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# THE
# SUGAR CANE:

A Monthly Magazine,

DEVOTED TO THE INTERESTS OF THE SUGAR CANE
INDUSTRY.

## VOLUME V.

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# THE
# SUGAR CANE.

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☞ The writers alone are responsible for their statements.

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## THE SUGAR QUESTION IN FRANCE.

There has been lately considerable agitation in France on the question of the duties and drawbacks on sugars, in which the Government officials of those departments interested, as well as the sugar manufacturers, refiners, and others have taken part.

The frauds on the revenue which the present system of types makes possible have attracted the notice of the Director-General of Indirect Taxes, who lately issued a circular on the subject, addressed to his subordinates in the service, calling attention to the practice of colouring sugars, by which he observes:—*Sugars of the saccharimetrical richness of* 94 *to* 95 *per cent. are reduced to the colour of the types* 7 *to* 9, *of which, according to the Cologne experiments, the richness is only* 80 *per cent;*" and he adds, "this method of colouration is employed with the manifest intention of defrauding the revenue." The officials are, therefore, called upon to take every suitable means of preventing these frauds. That the Government has acknowledged that the practice of colouring sugars exists, is an important point, although the circular of the Director-General is not likely to be very efficient in putting an end to it.

A document of more importance has lately been published, being a "Report on the *Régime* of Sugars," by M. Amé, Director-General of Customs, addressed to the Minister of Finance. In this report M. Amé, who was one of the Commissioners who represented

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France at the Conference held in London last August, shows himself to have been an opponent of the measure which this Conference met to discuss, that of refining in bond, and duty levied on sugars when going into consumption. It is worthy of remark that M. Amé and his colleague, M. Ozenne, were two of the minority of 5 against 20, who, at the conclusion of the inquiry instituted in May last by the Superior Council of Commerce of France, gave their votes against the system of the excise of refineries and duty on consumption. In his report, M. Amé intimates that this solution of the question was impossible, because of the strong objections of the Belgian delegates, and the want of sympathy of the Dutch, from whence he says, "it was evident that it would be impossible that the proposition of the English Government should command the unanimity of the delegates," which, considering in what direction the sympathies of the French delegates turned, is not to be wondered at.

M. Amé goes on to state that the delegates from Belgium, France, and Holland proposed a counter proposition, of which the object was to combine the principle of types with the application of the process of saccharimetry and analysis, as used in commerce; to increase the legal yield of the two lower classes of sugar, so as to lessen the drawback on export; to sanction the engagement entered into by France, to make her sugar duties harmonise with the scale of drawbacks on export; and to impose on Belgium the obligation of raising the estimated yield of the juice in her sugar factories.

It is very plain that but for the attitude taken by the French delegates, the results of the Conference might have been widely different, and the question have been then settled in the only way which will ultimately prove acceptable to the majority of those interested.

Almost the same time as Mr. Amé's "Report" appeared, the Commission which has been considering the "*Projet de Loi*" relative to the *régime* of sugars has presented its report (signed by M. Villain) to the National Assembly. The *Projet* was brought forward by the French Government above a year ago, and was designed to bring the assessment of duties into harmony with the provisions of the Convention of 1864, by establishing the correlation of duties and drawbacks in accordance therewith. The *Projet* appeared in the pages of *The Sugar Cane* at the time, but as presented by the Commission to the Assembly it was in several respects modified, not only by the addition of two-tenths to the duties, but by the alteration of several of its articles. The following is a translation of it as altered :—

Article 1.—From the time of the passing of this law the duties on sugar (including the tenths) are fixed as under :

| Description of Sugar. | | Yield of refined for export. | Amount of duty, per 100 kilos. Francs. |
|---|---|---|---|
| Refined ...... | Candy ........ | | 70·50 = 28/8 per cwt. |
| | Loaf or powder.. | | 70·50 = 28/8 ,, |
| Raw sugars, indigenous sugars, coloured sugars, and from those countries parties to the Convention of Nov. 8, 1864. | Above No. 18 .. | 96·00 | 67·68 = 27/6 ,, |
| | Nos. 15 to 18 inclusive. | 94·00 | 66·27 = 26/11 ,, |
| | Nos. 11 to 14 .. | 88·00 | 62·04 = 25/2½ ,, |
| | Nos. 7 to 10.... | 80·00 | 56·40 = 22/11 ,, |
| | Below No. 7.... | 67·00 | 47·23½ = 19/2½ ,, |

Article 2.—Cane sugars imported from foreign countries in foreign bottoms are freed from all surcharge of the flag.

Beet sugar originally from any of the countries parties to the Convention of 1864, and cane sugars from depôts in these countries, are also freed from surtax.

Article 3.—There shall be placed in each sugar manufactory, for the use of the service and of the *fabricant*, and at the Chambers of Commerce in the sugar producing departments, for consultation by the public, a series of types established by the present law, in accordance with the provisions of the Convention of 1864. These types shall be renewed at the latest every two years, in the month of May, to the knowledge of the Minister of Finance, and under the direction of the Minister of Agriculture and Commerce. The latter shall, for the preparation of these types, appoint a Commission composed of—

1.—A Raw Sugar *Fabricant*, who produces *poudres blanches* (vacuum pan sugar).
2.—A Raw Sugar *Fabricant*, who boils in open pans.
3.—A Refiner from some port.
4.—A Parisian Refiner.
5.—A Representative of the Colonies.
6.—Two Sugar Merchants.
7.—Two sworn Sugar Brokers from the Paris Exchange.

Article 4.—Sugars above No. 18 are admitted to the privileges of "temporary admission," and may be exported after refining immediately on the passage of this law. Their legal return from the refinery shall not be less than 97 per cent.

Article 5.—Whenever any dispute shall arise between the excise or the customs officers and the manufacturer or importer respecting the duty to be levied on sugars, which by their colour, from the extreme limit of any of the classes named in the first article of the present law, and recourse to a legal expert shall be demanded, the Expert Commissioners appointed by Article 19 of the law of the 27th of July, 1822, may, to assist their judgment, and as a means of control only, have recourse to either chemical analysis or saccharimetry.

Article 6.—All the provisions of law of 7th May, 1864, not altered by the present law, and those of the Convention of the 8th of November of the same year, and of the declarations of the 20th of November, 1866, and the 8th of November, 1868, are maintained in their form and purport.

This Report, when presented to the National Assembly, was the cause of a very animated discussion, some account of which, and of its important results, is given in a subsequent article.

## SLAVERY IN THE SPANISH COLONIES.

The Madrid correspondent of the *Journal des Débats,* writing on the slavery question in Spain, says:—

I recommend you not to allow yourself to be misled by the sort of insurrection which a large portion of the journals of Madrid and Catalonia have organised against the Ministry on this Colonial question, as there are other interests engaged in it than those of the nation. The matter concerns the emancipation of the slaves, and from what took place in England and France when that difficult question was raised, you can judge of the passions which it excites in Spain. A coalition has been formed of all the interests of the mother country, which are intimately connected with those of the colonies, and the result is a league which has called itself national, but which in reality only represents the maintenance of slavery, if not the continued traffic in negroes. Were you to read at this moment the journals of the association, you would see how they strive to interest in this affair the national pride, so easily excited in Spain. The directing order is to say that the measures taken by the ministry respecting Porto Rico coincides with the message of the President of the United States, which contains warnings addressed to the Spanish Government about the disastrous prolongation of the war in Cuba. President Grant declares that, in his opinion, the continuation of the civil war for four years is above all owing to the maintenance of slavery, and that he hopes the present Spanish Government will take the same view of the case. This intimation has been considered as an insult and a menace by all those who have an interest in maintaining the present order of things in the colonies, perpetuating negro slavery, and keeping Cuba in the proverbial state of a milch cow for the innumerable legion of functionaries from the mother country.

From another source we learn that—

The bill for abolishing slavery immediately and for ever in Porto Rico was read by the President in Congress on Tuesday, the 24th ult. It states that all the slaves in the island will be free four months after the promulgation of the law in the *Official Gazette*. The owners will be indemnified. The reading of the bill was frequently interrupted by cheers from many sides of the House. It was at the same time announced that the same reform would have been effected in Cuba, but the Government, in consequence of the insurrectionary movement in the island, was compelled with regret to postpone carrying out this intention. Section 1 provides that slavery is totally and for ever abolished at Porto Rico. The slaves become free at the expiration of four months after the publication of the present law in the *Official Gazette* of Porto Rico. Section 2 provides that owners of emancipated slaves shall be indemnified within the period mentioned in the preceding section. Section 3 provides that the amount of such indemnity shall be fixed by the Government on the recommendation of a Commission including three slaveowners. Section 4 provides that 80 per cent. of the sum fixed as indemnity shall be paid to the slaveowners, half of this amount will be paid on account of the State, the other half on account of the colony; the residue of 20 per cent. remaining at the charge of slaveowners. Section 5 authorises the Government to arrange by arbitration for a settlement of questions that may arise. Madrid telegrams assert that the opposition conservative press is fiercely opposed to the Government scheme for the immediate abolition of slavery in Porto Rico, but the Government is resolute to carry out its plan.

## BRITISH REFINERS AND THE CONFERENCE ON THE SUGAR DUTIES.

We understand that the Committee appointed by the Refiners of the United Kingdom, to conduct the negociations for a uniform system of refining in bond, in France, Holland, Belgium, and Great Britain, is about to issue a report in continuation of the one which they addressed to the trade in May last. In the meantime, we think our readers will be glad to learn how matters have progressed since then. Up to the date of the report to which we allude, the struggle had been with our own Government. The Committee found it necessary to prepare two memorials, the latter containing a voluminous statement of their case, and to go through a course of laborious agitation, both at home and abroad, before our Government could be induced to take the step of inviting a Conference for the purpose of remedying the present imperfect operation of the Convention of 1864. Their efforts were at length successful, and the Conference met on the 1st of August. The representatives of H.M. Government most courteously accorded several interviews to the members of the Committee, who took every opportunity of explaining the views of the trade. No official report of the proceedings of the Conference has yet appeared. This is extremely unfortunate, as a clear knowledge of what occurred would be of great value at the present moment. It is understood that the delegates of Great Britain adhered firmly to their position, that the present imperfect operation of the Convention could only be remedied by the adoption of the system of refining in bond in the four countries. It is further understood that their proposal was rejected by France and Belgium, but that Holland, frankly acknowledging that colour could no longer suffice to decide the richness of sugar, proposed that an inquiry should be instituted in each of the four countries, as to whether any system of analysis could be adopted which would be practically successful in assessing the duty on the raw material according to the amount of sugar extractable from it, and it is believed that Holland went on to state that it was prepared to adopt refining in bond if such a scheme were found to be impracticable. The opposition of France and Belgium left our representatives no alternative but to accept the very reasonable proposal of Holland, and it was arranged that the question of assessment by analysis should at once be examined by each country independently, and a decision come to, by the 1st January, 1873.

If this be a correct account of what passed at the Conference, the course pursued by France appears to us to be most extraordinary, for it must be remembered that the French Government instituted an enquiry in May last into the question of refining in bond. This enquiry was of a most searching character. All persons interested in the sugar trade in France gave evidence before this Commission, and a deputation of the Members of the British Sugar Refiners' Committee deposited with it the Memorial of their Trade, which they considered as the most convenient *résumé* of their arguments. They also drew up answers to a series of questions which had been issued by the Commission.

The report of this enquiry is now before the French public in a volume of over six hundred pages, which is to be followed by a similiar one containing the documents which had been deposited with the Commission during its sittings, which lasted from May 8th to July 25th. At the close of this laborious and thorough investigation, the Council, which was presided over by M. Pouyer Quertier, gave its decision in favour of the adoption of the system of refining in bond and the levying of the duty on sugar only in its finished state, and when it passes to the consumer

This decision was pronounced on July 25th, and at the Conference, which met in the following week, it was naturally expected that the representatives of France would support the proposal of England for the adoption of that system, more especially as they had been Members of the Commission, had heard the evidence, and had taken part in the discussion which led to that result. Belgium's principal argument is understood to be that such a system would not be acceptable to any trade in that country, and yet it is a well-known fact that the sugar manufacturers of Belgium voted in favour of it at the Trade Congress in Brussels last April, and that a nearly unanimous resolution in favour of it has since then been passed by them.

The proposal of the English Government having been thus rejected at the Conference, it appeared as if nothing more would be done in the matter till after the 1st of January. But events sometimes progress faster than official negociations. The losses to the French revenue arising from the present system, which had been predicted by the refiners in this country ever since the increase in the duties last winter, have begun to make themselves felt, and turn out to be much larger than they were then estimated at. Thus the present state of things has furnished its own condemnation. In the recent debate on the budget the attention of the National Assembly was called to the deficiency in the receipts from sugar, and to the fact that France had at first decided in favour of refining in bond, and then rejected it when proposed by England. The result was that when the *projet de loi* for assimilating the duties on home consumption to the drawback allowed on exportation came before the Assembly, it was sent back to the Commission, with instructions to prepare in its place a *projet de loi* for establishing refining in bond from the 1st of April next.

It appears from the speech of M. Pouyer-Quartier on that occasion, that the present loss to the French exchequer, owing to the payment of excessive drawbacks on exportation, amounts to as much as from five to seven million francs a month. Although the British refiners, in their representations to our Government, endeavoured to confine themselves to strictly accurate statements, which could be proved from acknowledged data, they were accused of exaggeration. It is now seen that the actual results far exceed their moderate estimations, and that they are at present contending against a competition which is receiving a protection of a more serious kind than that which the popular Free Traders of 1860 ever dreamt of.

We hope not only that the eyes of our own Government, and that of France, Belgium, and Holland will now be opened, but that other countries, and more especially Austria, will see how impossible it is to foster an industry by bounties on exportation, and at the same time secure a fair revenue. The duty in France is now 50 per cent. higher than it was in 1869, while the receipts have fallen 10 per cent., owing to the great increase in the bounties on exportation. The quantity of sugar consumed in France on the first ten months of 1872 ought to have produced at least 26,000,000 francs more revenue than has been actually received. These bounties now affect the British trade in three ways, by a protected competition in its home market, by a complete deprivation of export trade, and by a virtual fine on the use of the higher kinds of raw sugar by British refiners, since the quantity of sugar which they yield beyond the average of their class is worth to the French refiners five times what it is to the English. Hence not only do the British refiners obtain no bounty from the system which enriches their foreign competitors, but they positively lose by it, being driven either to use a quality of raw sugar inferior to the average of its class, and therefore yielding less than the amount of sugar on which it is assessed, or to compete for the higher kinds on which the foreign refiner now pays a heavy premium. We mention this in order to dispel the impression which seems to have arisen in official circles, that the British refiners in exposing the inequalities of the present system, are themselves exposed to the imputation of obtaining the bounties, though on a smaller scale. They can no doubt do so by using sugar above the average of its class; but in order to secure it they would have to compete for it with the foreign buyers, and, therefore, to pay a premium higher than the bounty which they would obtain.

We congratulate the trade on the present prospect of a speedy settlement of the question, and of a general adoption of the one true principle of raising revenue from sugar, namely, by levying it only on the manufactured article as it passes to the consumer.

# ON SUPERPHOSPHATES—THEIR ADULTERATIONS AND VALUATION.

BY J. EMERSON REYNOLDS, M.R.C.P.,

*Professor of Analytical Chemistry to the Royal Dublin Society, Keeper of the Minerals, &c.*

However much we may lament the existence of fraudulent dealing on moral grounds, it appears to me a study of high interest to follow this "trail of the serpent" amongst the things around us, to measure its effect upon the general welfare, and to devise means for its detection and suppression. In order to pursue such an inquiry with advantage, we must select a particular class of fraud; and the class to which I invite your attention this evening is that so frequently the subject of investigation by the analytical chemist—viz., the adulteration of articles of commerce. But I may further restrict the few remarks I have to make to a special order of adulteration which materially affects the agricultural community. The frauds to which I refer are those connected with artificial manures; but more particularly with the very important group of fertilisers included under the term "superphosphates."

We have had the opportunity of watching, for many years past, the steady development of a great trade in artificial manures, and the corresponding outcrop of devices by which dishonest traders have imposed on the farmer—with the result of diminishing his produce, and thus indirectly affecting the community at large.

To the agriculturist as to the manufacturer, the value of a superphosphate is directly proportional to the amount of soluble phosphate, insoluble phosphate, alkaline salt, and ammonia, either ready-formed or latent, that it contains. A very few seasons since, it was by no means uncommon to meet with superphosphate sold at a good price, and containing *no* soluble phosphate, and but a small proportion of other valuable substances;—clay, road-stuff, gypsum, or waste products of various kinds from chemical works being used up in preparing the very feeble fertiliser. The same materials, of little value, were still more frequently used for diluting the genuine manure, and this practice is far from being uncommon at present.

I need not stop to consider in any detail the effect of this dishonest dealing on the farmer—his wasted means, unrequited labour, and consequent disappointment. To do more than refer to these misfortunes, and to the consequent national loss, would be to repeat an oft told tale.

The adulterators of superphosphate, bold though they were at first, soon received a check, for agricultural societies employed chemists in the detection of the frauds, with the result of obliging the greater cheats either to rest satisfied with the profits derivable from small adulterations, or to transfer their attentions to guanos or other substances that could be rather more safely tampered with.

Speaking now from my experience as chemist to this Society, I am justified in stating that gross adulterations of superphosphate are now rarely practised—probably not because the dishonest dealer has lost the desire for large profits, but for the sufficient reason that the risk of detection is now too great. He has, therefore, fallen back upon the more subtle plan of mixing with a manure a quantity of some nearly worthless substance that it already contains as a natural constituent. The addition of gypsum to a superphosphate is an adulteration of this kind, for all these manures contain gypsum as a necessary product of the action of oil of vitriol on phosphate of lime, whether the latter is derived from bones, coprolites, or other similar mineral phosphates. When this addition of extraneous gypsum falls within certain limits, it is difficult to prove the adulteration, as manures of the same kind, and honestly prepared, are known to vary somewhat in composition. Now, under these circumstances it will be asked, What control have we over this more refined kind of adulteration? The answer to this ought to be, that a complete system of chemical valuation is employed by means of which any sensible reduction from a common standard is at once detected. But such an answer cannot as yet be truly given. Manures of the class referred to certainly have money values attached to them after analysis made on behalf of the purchaser or the vendor; but a very few examples will suffice to show how little importance is to be attached to such estimates. Thus, we find a manure selling at £6 per ton valued at £8 15s.; another, whose selling price is £6 5s., valued at £9 8s.; others, sold at £6 10s., £6 6s., and £7, appraised by one chemist at £7, £8, and £8 10s., respectively; and by another at £6 18s., £7, and £7 2s., though the two sets of analyses fairly agreed and were made about the same time. These discrepancies are accounted for to a considerable extent by supposing that one chemist attaches much more importance to certain constituents than another does; one values in the interest of the vendor, the other in that of the purchaser, and all the estimates are wide of the truth. Valuation of this kind, however, is probably useful for purposes of comparison when a particular set of samples are under examination; but, for general use, the system is simply misleading, and unable, in its present guise, to afford the information we require in dealing with doubtful cases. Hence, about three years ago, I ceased to assign money values to manures, unless where specially requested to do so on receiving a sample for analysis. I understand that Dr. Vöelcker, the distinguished chemist to the Royal Agricultural Society of England, now declines to attach a money value to a sample of manure under any circumstances.

Nevertheless, a satisfactory system of valuation ought to be constructed, as it is capable of rendering great service. I venture to think that no insuperable difficulties lie in the way, and my chief object is to lay before you the details of a plan for estimating relative values of superphosphates which appears to be fair alike to vendor and purchaser. If I succeed in proving to you, in the first place, that we may precisely fix the relative commercial values of the constituents of a superphosphate; and, secondly, that we can take a standard to which reference can be made, it will be easy to complete the work and to show how the data may be utilised.

In dealing with the first branch of this question, it is well to explain at the outset the method of valuation at present employed. A certain money value per ton is assigned to each important constituent of a manure, thus: Ammonia, at £95 per ton; soluble phosphate, £30; insoluble phosphate, £11; alkaline salts, £3; organic matter, £1; gypsum, £1. A sample is analysed, and the percentage statement is held to indicate the composition of 100 tons. The number of tons of each body present is then multiplied by its price per ton, the various amounts then added together, and the estimated value of 100 tons obtained.

Having indicated the system at present in use, we now have to fix the relative values of the important constituents, by consulting dealers in the several raw materials as to their cost, and manufacturers of manure as to the expense attending the necessary treatment, excluding charges which do not affect the *relative* values. I have to acknowledge here the promptitude and courtesy with which my inquiries have almost invariably been met by many merchants, agents, and manufacturers. Without giving details of outlay, with which I have been kindly furnished in confidence from several quarters, I may now state the table of equivalent numbers that I have been thus enabled to construct, and these represent the mean of the several values at the present time. We may eliminate the organic matter that appears in an analysis from our list, since I give the equivalent of its latent ammonia, and gypsum, also because the equivalent of biphosphate includes that of the corresponding sulphuric acid of the gypsum. The table is therefore limited to the following six bodies, and these are referred to ammonia as unity:—

| | |
|---|---|
| Ammonia, ready formed.. .. .. .. | 1·0 |
| Ammonia, latent .. .. .. .. .. | 2·2 |
| Biphosphate .. .. .. .. .. .. | 4·0 |
| Bone phosphate .. .. .. .. .. | 8·0 |
| Mineral phosphate .. .. .. .. .. | 13·0 |
| *Alkaline salts .. .. .. .. .. .. | 22·5 |

This table somewhat resembles that of equivalents of the elements used in chemistry; that is to say, the numbers are strictly proportional to one another, and indicate the replacing values of the different bodies to the manufacturer.

The table also fairly represents the average relative values of the several substances to the farmer. Now, though the *average* agricultural values are not subject to fluctuation, the numbers in the above table require slight corrections to be applied to them from time to time, owing to variations in the *relative* cost of materials. Where any change of the kind is necessary, the correction should be applied prior to the commencement of each season, in order that all manures sold during a particular period should be fairly judged in the same way.

We have therefore substituted for money values a series of proportional numbers that can be used with great advantage, and have thus made the first step toward the solution of the proposed problem. As an example of the mode of using the figures, I may give the following analysis of a fair mineral superphosphate offered for sale at £6 per ton :—

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* See following page.

100 parts contained—

| | | | |
|---|---|---|---|
| Water | 12·85 | | |
| Organic and volatile matter | 22·65 | | |
| Biphosphate | 16·99 | ÷ 4·0 | = 424·2 |
| Neutral phosphate (mineral) | 12·25 | ÷ 13·0 | = 94·2 |
| [*] Alkaline salts | 1·50 | ÷ 22·5 | = 6·6 |
| Sulphate of lime | 29·06 | | |
| Sand, &c. | 4·70 | | |
| | 100·00 | | |
| Ammonia | 0·40 | ÷ 1·0 | = 40·0 |
| | | | 565·0 |

In the above analysis, not made by me, the ammonia is not stated to be ready formed, nor is it shown to be latent. Under these circumstances, I consider it fair to the manufacturers to assume that it is immediately available, though it is highly improbable that all the nitrogen exists in the manure as ammonia. The per-centages of the four valuable constituents have been divided by the corresponding equivalent numbers, and in the products the decimal points shifted two places to the right, in order to get convenient terms. The numbers have then been added together, and the product I call 565° on the R. D. S. scale of relative value. Instead of shifting the decimal points in the products, we may obviously do away with the decimal points in the analytical statement, and take the numbers given to represent parts in 10,000.

I now give a number of analyses of mineral and bone superphosphate made by different chemists. The samples are numbered, and the manufacturers' names suppressed, for obvious reasons. The *agents'* price to the farmer is given in each case, and the degree of the manure marked on the plan just described.

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[*] The value of alkaline salts varies chiefly according to the proportion of potash salts present. In my opinion, it would be unfair to the manufacturer to assign to them a lower relative value than that given in the table.

### SUPERPHOSPHATES.

| | MINERAL. | | | | | BONE. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2. | 3. | 4. | 5. | 6. | 7. | 8. | 9. | 10. | 11. | 12. |
| Selling price per ton | £6 | £6 10s. | £6 10s. | £6 10s. | £6 10s. | £8 | £8 | £8 | £6 15s. | £8 | £8 |
| Degrees on Royal Dublin Society's scale | 595° | 630° | 615° | 520° | 509° | 883° | 537° | 600° | 573° | 655° | 811° |
| Water | 16·10 | 15·97 | 17·50 | 23·30 | 19·75 | — | 18·70 | 14·40 | 16·60 | 14·37 | 8·20 |
| Organic matter, &c. | 17·52 | 14·53 | 12·25 | 15·70 | 16·95 | 37·39 | 16·59 | 25·25 | 28·25 | 23·98 | 21·53 |
| Biphosphate | 15·92 | 20·55 | 19·52 | 14·36 | 16·15 | 11·30 | 14·30 | 11·05 | 12·72 | 17·40 | 19·28 |
| Neutral phosphate | 10·00 | 13·10 | 14·90 | 14·33 | 6·80 | 18·00 | 2·60 | 4·55 | 8·55 | 8·40 | 16·25 |
| Alkaline salts | 4·55 | 0·80 | 0·46 | 2·45 | 0·52 | 3·00 | trace | 3·44 | 1·95 | 1·05 | 1·45 |
| Sulphate of lime | 32·89 | 30·80 | 29·42 | 26·11 | 35·31 | 27·71 | 41·41 | 36·16 | 27·75 | 31·10 | 27·47 |
| Insoluble matter | 3·02 | 4·25 | 5·95 | 3·75 | 4·52 | 2·60 | 6·40 | 5·15 | 4·18 | 3·70 | 5·82 |
| | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 |
| Ammonia | 1·00 | 0·13 | 0·12 | 0·12 | 0·30 | 3·62 | 1·49 | 2·53 | 1·40 | 1·10 | 1·20 |

*(To be continued.)*

# THE PALMS IN JAMAICA.

The following very valuable Report from the Superintendent of the Botanical Gardens in Jamaica, on several of the Palms and other plants indigenous to the island, was published in the Supplement of the *Jamaica Gazette*, by direction of the Lieutenant-Governor :—

*(Copy.)*

CINCHONA PLANTATIONS, GORDON TOWN,
P. O. 28TH SEPTEMBER, 1872.

SIR,

His Excellency the Governor having requested that all the indigenous palms should be under cultivation at Castleton; and as respecting several of them information was required in order to determine their identity, I beg to report, that with the view of accomplishing this, I recently visited, in search of palms which are usually very local in their distribution, various parishes in which they are found. I proceeded to St. Ann's, on the one side of the island, to St. Elizabeth, and part of Westmoreland on the other; of course including, in the scope of my research, the intervening and contiguous parishes. The result of this tour, although it has left room for further information, as also the acquisition of flowers, or the seeds of two or three species which were not obtainable, is the addition to the collection at Castleton of seven or eight species, of which all, except perhaps one or two, are new to cultivation in Jamaica. A considerable number of plants, and several hundred thousands of seeds, chiefly for distribution to other botanic gardens, were likewise procured, and I am of opinion that, probably, there are not now more than two species in the island not obtained. As I have recently had the honour of submitting to his Excellency special reports upon the Cinchonas of Manchester, I shall at present confine my observations more particularly to the subject of palms, and secondarily to a few of the other products of the country, which I deemed most worthy of consideration.

Cocoanut.—This palm is generally diffused throughout the maritime parts of all tropical countries. In Jamaica almost everywhere we are accustomed to see this useful and beautiful tree in constant vicinage to the dwellings of the peasantry, and luxuriating in all the climates, from the most arid to the most humid, which the island affords. Here, however, as in other countries, it recedes in productiveness in proportion to its distance from the congenial influence of the sea. "It is seen on the arid sandy shores with its roots laved by the surges, as well as in the rich valleys, overshadowing the huts of the natives; but when it is found inland it is inferior in size to what it is on the sea shore, and about the dwellings of natives." A curious anomaly as regards this general distribution of the cocoanut is manifested to the south westward of the island; along the coast, for about twenty miles on either side of the town of Black River, there is almost an entire absence of this tree in a fruiting state. Taking for example the neighbourhood of the above town, there are numbers of young cocoanut trees, from six to twelve feet high, in an apparently healthy state, but as soon as they flower to fruit, and mostly too on the first occasion of their doing so, they assume a sickly aspect and die; a tree sometimes indeed produces a few fruit, but it then certainly perishes. I observed this phenomenon among several groups of trees, miles apart; my observation, it is true, extended only to one side of this exceptional tract, of which I have stated Black River to be the centre, but on approaching Savana-la-Mar, it was evident that the cocoanut began to thrive, since, in that town, a considerable number of fruiting trees exist. I cannot account for this peculiar absence in this district, of the conditions pertaining to the growth of the cocoanut. In Black River, indeed, I have heard it ascribed to the presence of some insect, and this opinion I consider deserving of strict investigation. In various parts of the East Indies an insect is fatal to the growth of the cocoanut. It would be highly interesting to try the King cocoanut on this plain, as a probable means of effecting the establishment of an important product.

SILVER THATCH "(Thrinax Argentea)."—This is a fan palm, from ten to twenty feet in height, with leaves from two to three feet in diameter. The fibres of these leaves, which constitute the value of the plant, are extremely tenacious. Silver Thatch abounds in St. Elizabeth, most frequently growing out of the bare rocky crevices, or on the sandy sea beach; and although in this island only used in the districts in which it is found for thatching huts, and making a few brooms and ropes, it is by far the most useful of the indigenous palms. Large quantities of the leaves of this palm are exported to England from Panama, Cuba, and the Central American territories. In St. Alban's, and the villages around it these leaves are plaited into chip hats, or, as they are sometimes called, grass hats. It is also supposed that it is the leaf of this palm which is manufactured into the so-called straw hats in Columbia, of which, in one district of the country, the average weekly sale is 600 to 800 dozen, and for the finest quality of which as much as £1 10s. each is obtained. These hats are largely exported to the United States and to Havana. In Jamaica, as I have observed, it is chiefly used for thatching, and for this purpose I consider it the best adapted of all palms in Jamaica or elsewhere. A great traveller, and authority in palms, says, "nothing is more suitable for roofing in the tropics than palms, if the proper ones can be obtained; their coolness is something delightful." I understand that considerable quantities of excellent brooms, made from the leaves of this palm, are exported from Panama and other places. In this island very few are made of this material, whilst there can be no doubt that a sufficient supply for home use at least, might be manufactured, and that too of a more durable quality than those made from the "Palmetto straw," so largely imported from Cuba, or than those which are made in different parts of the country from greatly inferior material. I am told that the ropes which are also to a very small extent made from this thatch, are usually considered superior to those from the other fibres of this island. Besides the other uses of this fan leaf, it is not improbable that for making hats it might be found equal to that of the Iipijapa "(Carludovica Palmatta)", a palm-like plant, belonging to an allied family, which are made into the celebrated Panama hats.

The most conspicuous of indigenous palms, both with respect to its abundance and the peculiar aspect it presents, is the large Fan Palm "(Sabal Umbraculifera)". The St. Elizabeth plain, where this palm abounds, exhibits an appearance strangely different from that of any other part of the country. This tree sometimes rises to the height of eighty feet, and the leaves, which are of a peculiarly bright shining green, have a diameter of about six feet. These leaves are likewise largely employed for thatching purposes. The hard outer crust of the trunk, together with that of the Long Thatch, a palm closely resembling the Cocoanut, is to a considerable extent split into laths, about four inches broad, for boarding huts and making fences, and is so used in the town of Black River. Owing to the very superior thatch, and the staves made from these palms, the negro houses in this part of the island present a decidedly better appearance than elsewhere. The "Palmetto Straw," imported from Cuba, is a species of the large Fan Palm (Sabal) and very similar. The value of the importation from Cuba of this Palmetto straw, last financial year, amounted to £594. The price of each leaf in Kingston is from threepence to sixpence, where it is extensively made into straw hats, baskets, and brooms. In St. Elizabeth the large Fan Palm is sometimes made into hats, and it is probably not inferior to the "Palmetto Straw" imported; at all events, between our "Silver Thatch" and this large Fan Palm, surely the importation of the Cuban material might be obviated. I found another species of Sabal, not hitherto described as indigenous to Jamaica.

MANGOES.—In many parts of the island, the Mango, although it has only been introduced for ninety years, has become one of our commonest trees. On many hills indeed, and in several low lying parts of the country almost destitute of other trees, a semi-forest of Mangoes has sprung up; the Port Royal Mountains, for instance, are becoming to a great extent a Mango forest. On these mountains it thrives everywhere to a height of 3,500 feet, above which elevation, unless in exceptionally hot dry seasons, it ceases to bear. In St. Ann's and Manchester, this tree equally abounds, but in certain localities, of considerable extent in both parishes, it has ceased to yield for many years, although formerly it bore plentifully. I am unable to account for this degeneration as regards fruit, since the tree itself presents the usual luxuriant and healthy appearance; it can hardly have resulted from any slight physical change in the soil, or in any abrupt alteration of temperature or humidity. It is probable that a stock of Mangoes, transported to these districts, would flourish as well as they did formerly; and the chances of insuring this would, most likely, be greatly enhanced by a trial of several varieties of our new Indian Mangoes grafted here.

BREAD-NUT.—This lofty tree is one of the most important indigenous products of Jamaica. It is an ally of the Bread-Fruit, but very dissimilar in appearance. It is also unlike the commonly cultivated Bread-Fruit, in its being exclusively confined to the localities in which it is spontaneously produced, namely, in and near St. Ann's and Manchester. Almost every part of this plant, leaves, twigs, and seeds, is utilised for fodder, and is highly appreciated by large penkeepers, who indeed consider it more nutritious for horses and cattle than even corn. When used for fodder, which is chiefly in seasons of drought, when the pastures are burnt up, the branches are lopped off and given to the stock; and race horses are often constantly fed in this way. The seeds of this plant are also an agreeable article of human food, so that were it largely planted in countries subject to drought and famine, it might possibly prove a great blessing to them. I would observe, in the last place, regarding the utility of this tree, that its timber, which possesses a peculiarly veined grain, is of considerable value as a cabinet wood. No attempt, so far as I am aware, has been made even in Jamaica, to disseminate this precious tree, although its diffusion throughout the island would no doubt prove beneficial in mitigating the effects of frequently recurring droughts. I have procured both from St. Ann's and Manchester a considerable number of seeds, with a view to their distribution.

LOGWOOD.—The greatly increased traffic in Logwood during the past few years seems to have given rise to the opinion that the supply is all but exhausted, and must continue so for a period of years, and I have no doubt this to some extent may be the case in the more immediately accessible parts. But yet, this very exhaustion of the marketable article is not without its advantage, as it must necessarily greatly promote and accelerate the cultural production of an increased future supply, inasmuch as the removal of the older trunks largely increases the area for the expansion and development of the multitudes of young trees ready to take their place. This tree, which is usually the only thing of value on the land it occupies, has been introduced into the island for about a century and a half, during which it has undoubtedly taken possession of a greater area of the country than is occupied by any other tree. The extent of land covered by this product, and that too in some large tracts almost so entirely as to the exclusion of every other kind of tree, lies for the most part contiguous to the sea, and may, I think, be moderately computed at two hundred square miles. I have alluded to the density with which this plant frequently covers the ground, and indeed this is so great that in their struggle for existence, the few which gain the mastery are still much impeded in their progress to maturity, since in most cases very limited attempts are made to facilitate growth by giving a little attention to thinning out the thick underwood, although an underbilling of the bush, perhaps once in two or three years, is all the cultural attention necessary. It is from the consideration of this fact that I argue the advantage to the future of this product from the briskness in the trade for some time past. If my estimate of the extent of land occupied by Logwood be near the mark, I feel assured that with the slight degree of attention I have mentioned, the gross production of the island could not be less than three hundred thousand tons a year.

Coffee.—The cultivation of the Coffee plant in Jamaica is remarkably accommodating to all varieties of climates and soils which the island usually affords, from the comparatively arid to the most humid of the former, and of the latter, from the level of sea up to nearly 5,000 feet. Amongst all the exported commodities this one is most generally produced, and is the mainstay of the peasantry. It is their favourite ambition to own a plot of Coffee as being a product which always commands a ready money sale. This cultivation by the peasantry is replacing, and in some degree compensates, for the rapidly diminishing production of the large plantations. In one respect this is greatly to be regretted, viz., in regard to the very inferior article produced by the small settlers, compared with the renowned coffee of the large plantations, the latter being in value worth about one hundred per cent. more than the former. This discrepancy in some measure arises from the more favourable conditions of climate in which the plantations are situated, but it is also in a great measure the result of the rude and indifferent method of curing and preparing for the market pursued by the settlers. As a strong proof of this great difference in value between the production of the large plantations and that of these settlers, it may be remarked that the coffee obtained from these settlers in a fresh state, and manufactured by the large planters, is greatly increased in value—perhaps not less than fifty per cent. In regard to the subject of cultivation by the small settlers, it would also be very desirable, if some method could be adopted for stimulating them to more careful attention to cultivation, as this would largely increase the production of the plant. Among the defects of their system of cultivation may be mentioned the following: the thick intermixture with the Coffee of fruit and other trees, as well as provisions, (for although some of these trees with the Plantain and Banana, if sparsely scattered throughout their grounds, are certainly favourable to shade, more especially in a dry climate), yet as they carry out this method of inter-planting, so dark and dense a shade is formed, and the soil is so impoverished that the Coffee becomes spindly and weak, with only a few branches and leaves at the top. Again, the Coffee trees themselves are sometimes permitted to grow so thick together that they have more the appearance of weeds than a cultivated plant, owing to the impossibility of the rays of the sun ever penetrating them, and to the circulation of air effecting its office. Another phase of non-cultivation exists in weeds being allowed to choke the plant. I hope there are indicated in these remarks some reasons worthy of consideration, on the part of the Government, why the small planters of Coffee should receive encouragement to adopt a more intelligent and profitable method of curing and cultivating it.

PIMENTO.—This well-known product of Jamaica abounds in several parishes, but chiefly in St. Ann's. There are two perfectly distinct varieties of the plant, one of which is popularly called the "male tree," and is constantly found in companionship with the other, or bearing tree. Notwithstanding the assertion of botanists, giving advice on the subject, that as the bearing tree possesses both male and female organs, and is consequently capable of self fertilization, the male tree is futile, and should therefore be destroyed, large owners of Pimento have maintained from experience, that the male tree is indispensable to fertilisation, or at all events, to a good crop. If the futility of the male tree could be once satisfactorily established, it would be a matter of importance, as it would inspire confidence in the growers to destroy these, which at present occupy about a fifth part of most plantations. Both kinds of trees possess hermaphrodite flowers, and the male on some occasions produce a few small fruits. I regret that I have not had sufficient opportunity of testing, and which I think further investigation will tend to confirm, namely, that the male plant possesses much stronger male organs, and *vice versa*, the bearing plant much stronger female ones. Should my observation prove correct, the utility of the male tree in the plantation can easily be understood. The Pimento, besides being a valuable spice is also in great demand for walking and umbrella sticks. These are annually exported to England in large quantities in their rough state, where they fetch from fourpence to eightpence apiece. For walking sticks they are manufactured into almost every variety of fanciful patterns by staining, carving, and other processes, and the wood being very strong and close grained, admits of its general adaptation to almost any purpose. For umbrellas they are very useful, for their rigid nature prevents their breaking or becoming crooked; at present to collect say 20,000 suitable sticks, a very large area of land must be searched, whereas one acre under cultivation for this sole purpose, almost every stick would be available, and also superior to the generality of those obtained at random, whilst by planting it at about one foot apart it would produce upwards of 40,000.

BLACK RIVER PLAIN.—The most remarkable circumstance connected with this extensive and beautiful district is the entire absence of any attempt to utilize, for agricultural purposes (except perhaps on a few acres), the stream which flows through it with a navigable length of thirty miles, and from which it derives its name. Notwithstanding the unsurpassed facilities for irrigation, there are not many hundred tons of sugar produced throughout this whole plain of probably not less than 200,000 acres. A considerable portion of this plain is in morass, which must undoubtedly contain some of the richest land in Jamaica. Among the means of drainage which might be employed may be mentioned for instance, the Cornish pumping engine, which will, with 112lbs. of coal, lift 50,000 tons of water one foot, a single engine of one hundred horse power being equal to the work of reclaiming about 10,000 acres of land. There can scarcely be a doubt that, were this splendid expanse of country abundantly watered, more sugar than the present yield of the whole island could be produced in detached, selected pieces, and at the same time the present average yield doubled and trebled. I feel indeed convinced, that from all its great natural advantages, this plain is destined to be at some future time, however distant, one of the richest spots in the West Indies. Whilst touching upon the subject of sugar, in connection with this district, it may not be altogether amiss to express my own settled belief that the time is not far distant, if Jamaica is to hold her own in the wide spread rivalry of sugar production, when central factories must inevitably be instituted. Under such a system the peasantry would be able to sell their cane by the ton to the large manufacturer with great advantage, and this would undoubtedly give a great impetus to the present rude system of cultivation and manufacture pursued by them. But besides this, other advantages might also be expected to follow; thus, for instance, the people would, by force of competition and experience, be brought to perceive the vast disparity in the weight of canes yielded per acre under different conditions of cultivation ; at present an acre, under long-continued and wretched cultivation, does not sometimes produce over a ton, whereas under high culture the yield ought to be from twenty to thirty tons.

A considerable portion of the area of Jamaica—hundreds of square miles—is characterised by low rocky hills, with little or no soil, on which systematic tillage could not be conducted, but the utilization of which is of great importance to the future of the Colony. I have already referred to the great value of the two spontaneous products, Silver Thatch and Logwood, the latter of which flourishes in places so poor, that the soil is unfit for ordinary agricultural purposes, and could scarcely be turned to any other purpose, whilst the former, although at present limited in its distribution and quantity, luxuriates where found on a still more barren condition of soil, being chiefly found on the crevices of the naked rock, or on the sandy sea shore. If therefore, pursuing the purpose for which nature has intended it, steps were taken to disseminate and establish Silver Thatch over the said barren wastes, which are so peculiarly suited to it, the future benefit to the resources of the country would undoubtedly be very considerable.

I have, &c.,

(Signed) Robert Thomson,
*Superintendent Botanic Garden.*

*The Honourable the*
*Acting Colonial Secretary.*

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## MINERAL COTTON.

This so called mineral cotton has lately been recommended as a good covering for steam boilers and steam pipes. It is obtained by introducing a jet of steam into slag or scoria when in a red hot or molten state. By the action of the steam it is reduced into the finest fibres which, when pressed together, produce a mass similar to cotton, suitable for the above application in consequence of its non-conductibility of heat, and its porosity.—*Zeitschrift fur Zuckerindustrie.*

# ON THE INFLUENCE OF FORESTS ON RAINFALL.

### BY ALFRED FRYER.

(Continued from page 649, vol. iv.)

"*Connection between the Rainfall, Elevation, &c. (in Mauritius.)*—Taking the elevation alone into account, the results of five years' observation (1862-66) at nine stations, show that the rainfall increases with the height up to about 1000 feet, and then decreases; thus:—

| Mean height.<br>Feet. | Mean Rainfall.<br>Inches. |
|---|---|
| 120 | 44·712 |
| 500 | 67·985 |
| 915 | 106·907 |
| 1250 | 67·730 |

"But there must be other conditions affecting the rainfall, for we find such anomalies as the fall at 960 feet being double the fall at 930 feet, and the fall at 50 feet being double the fall at 130 feet. Now, these discordances disappear when we take into account the side of the island on which the gauge was placed, and the distance from the east coast, as well as the altitude. An analyses of all the observations, with respect to the several conditions, leads to the following conclusions:—

(1.) "On either side of the island the rainfall increases, from the coast up to the highest station on that side, and attains a maximum at or near the summit of the eastern declivity, the line of maximum fall extending from near Labourdonnais in the north, away to the southward, passing probably to the east of Esperance, and to the west of Cluny, and thence to the neighbourhood of Grand Bassin and the Savanne mountains, in the south; and along this line the maximum rainfall itself varies, and is greatest on the highest and most wooded parts of the island, near the commencement of the slope to the east."

(2.) "The rainfall on the east coast is from two to three times greater than on the west coast."

(3.) "From the east coast westward to the highest station on the eastern side, the increase of height is to the increase of rainfall nearly in the ratio of 5 to 2, and from the west coast eastward, to the highest stations on the western side, nearly in the ratio of 5 to 1."

(4.) "The rainfall at Esperance, one of the highest stations on the western side, is four times the rainfall at Gros Cailloux, on the west coast; and the rainfall at Cluny, the highest station on the eastern side, is little more than twice the fall at Beau Vallon and La Gaieté, on the east coast, and five times the fall at Gros Cailloux."

(5.) "If the other conditions be the same, the nearer the station is to the east coast the greater the rainfall."

"There are apparently two exceptions to this last remark—the first is in the case of St. Aubin, near the southern extremity of the island, where the mean rainfall is considerably greater than at stations on the east coast, being for two years (1865-66) 93·057 inches. But the prevailing wind arrives at St. Aubin without passing over much land, and immediately to the northward of it, there are steep ascents and high mountains."

"The other exception is in the case of Flat Island, a small island about five miles north of the most northern point of Mauritius. The mean rainfall there for two years, (1862-3), at 30 feet above the sea-level was 32·280 inches, against 30·908 inches, and 29·350 inches at Port Louis and Gros Cailloux respectively, for the same period. But, though that island is further east than other stations at which the rainfall is much greater, it is at a greater distance from high land, and as it is but a small speck in the ocean, and the prevailing wind does not come to it from the main land, it would seem that the rainfall there represents approximatively at least, the rainfall at sea; and if it does so, it follows that fully one-half of the rainfall of Mauritius is due to local causes, such as elevation."

"*Distribution of rainfall according to Season, &c.*—The following is the order of the months, according to the amount of rainfall. February, January, March, December, August, April, May, July, June, November, October, September."

"During the four months of December to March, the rainfall is above the mean monthly fall for the year, and during the other eight months below it. Hence the former months may be regarded as the *rainy season*, and the latter as the *dry season*. The term dry, however, applies with much more force to the three months of September to November."

"An analysis of the observations shows:—

"(1.) That over the island, generally, 58 per cent. of the annual rainfall falls in December to March, whilst only 11 per cent. falls from September to November."

"(2.) That the seasons with respect to rainfall are much more distinct at the stations where the annual rainfall is least; that is, generally, at or near the coasts, and particularly on the west coast, as at Port Louis and Gros Cailloux, where 67 per cent. of the rain, for the year, falls in December to March, and only 7 per cent. from September to November."

"We thus see that the conditions which produce a much greater annual rainfall at certain stations, likewise tend to obliterate the distinction of seasons into dry and wet."

"During fourteen years' observations at Port Louis, the greatest rainfall in any one month was 46·570, in February, 1861, and the least, no rainfall at ll, November, 1859, and November, 1866, (this latter month being the least rainy on record). The greatest fall at Gros Cailloux for any one month during five years, (1862-66,) was 13·420 inches in February, 1865; and the least 0·150 inches in November, 1863, and September, 1865. At Cluny, for the same five years, the greatest fall in any one month was 43·600 inches, in December, 1865; and the least, 1·090 inches, in November, 1863. The greatest and least falls at the other stations, for any one month, were intermediate."

"The greatest rainfall on any one day at Port Louis, in each year, during fourteen years (1853-66,) ranged from 10 inches, on the 15th February, 1861, to 1·720 inches, on the 24th March, 1866. At the other stations the greatest rainfall on any one day took place on the 12th February, 1865, and on the 27th and 28th December, 1865, on which occasions the fall, in twenty-four hours, ranged from 25 to 6 inches."

"*Rainy days and rain-bearing winds.*—The results for Port Louis under this head are as follows :—

"The mean annual number of days on which rain falls is 134, viz., 16 in January, 17 in February, 15 in March, 10 in April, 9 in May, 8 in June, 11 in July, 12 in August, 7 in September, 8 in October, 9 in November, and 12 in December."

"Hence the fluctuation in the frequency follows the same law as the amount of rainfall."

"The number of times rain may be expected to fall in the course of the year, with the wind from each of the principal points of the compass, is as follows: north 6, north-east 13, east 51, south-east 40, south 3, south-west 1, west 3, north-west 10, calm 3."

"Here we see, as might be expected, from its vast preponderance, and its coming over a great expanse of evaporating surface, that the principal rain-bearing wind is the trade wind, from S. E. to E. N. E."

"In proportion to their frequency, however, the northerly and north-westerly winds bring fully as much rain as the trade wind, and some of the heaviest downfalls have been with the wind from the north and north-west, as in the 12th February, 1865."

"When rain from the north-west is general, the relation between the east and west coasts with regard to rainfall is reversed; which shows that the east coast owes its greater rainfall to being on the windward side of the island."

"The rainiest hours of the day are from 1 to 5 p.m."

"*Fluctuations of the Annual Rainfall :*—The last columns in tables I. and II. would exhibit the secular variation at Port Louis, so far as that could be done by fourteen years' observation, if the same gauge had been used under the same conditions."

"Yet it is evident, that from 1853 to 1856, the rainfall at Port Louis increased, and then decreased to 1858, the last year of the six years' series; that from 1858 to 1861 is increased, even at 40 feet above the ground; and that from 1861 to 1866, a very marked decrease took place."

"The total rainfall during the last five years (1862-66), of the whole period of fourteen years, (1853-66) was 151·265 inches, against 211·579 inches during the first five years, (1853-57), and 237·041 inches during the five years (1857-61), leaving for the last five years (1862-66), deficiencies of 70·314 to 85·776 inches respectively."

"These deficiencies are partly due to difference of elevation, but after making ample allowance, we find that the rainfall during the five years, (1862-66), was considerably less than during any previous five years of the whole period."

"Comparing now the monthly and yearly results for those five years, or (taking in 1861) for the six years (1861-66) *inter se*, and with those of the previous eight years, we find that the monthly and annual fluctuations were much greater in and after 1861 than before it. From 1861 to 1866, the yearly fall at Port Louis fluctuated between 68·733 and 20·571 inches, whereas, during the previous eight years, it only fluctuated between 46·655 and 35·341 inches; the fall in 1862 was less than half the fall in 1861, and the fall in 1866 less than half the fall in 1865. Again, in no former year of the period of fourteen years did such floods occur as in 1861 and 1865, or such severe droughts as in 1865 and 1866."

"The fluctuation of the annual rainfall in other parts of the island, during the five years 1862-66, will be seen in p. 618 vol. iv., an exmination of which, will show that the rainiest stations are subject to much less variation than the least rainy. Thus, at Cluny, the greatest and least annual falls were 192·45 and 122·48 inches, whereas at Gros Cailloux they were 36·57 and 20·72 inches, and at Port Louis 44·737 and 20·571 inches. Hence the conditions which make certain stations much more rainy than others, render the amount of annual fluctuation less."

"We do not know from direct observation, whether the rainfall over the island generally was less from 1862 to 1866, than during any previous five years; but the relation which is found to subsist between the rainfall at any one station and at all the stations, enables us to state that the diminution observed at Port Louis, was not local, but general. The tables show clearly that, *if the rainfall increases or diminishes at any one station, as Port Louis, it increases or diminishes at all the stations without exception.* Hence, as the rainfall at Port Louis was less during the five years, 1862-66, than during any former five years since 1853, we infer that there was a similar decrease over the whole island."

"We know also, that in the course of that period, there were excessive floods and droughts at all the stations, and that the sugar cane, and consequently the general interests of the Colony suffered greatly. And, as if it was not enough that vegetation alone should be blighted, the driest year of all (1866), was followed by an epidemic, which swept away fully one-tenth part of the population."

"*Destruction of the Forests.*—The period of observation is too short to enable us to arrive at a satisfactory conclusion as to whether the decrease of rain in Mauritius, since 1861, is temporary or permanent. But, as during the last fifteen years, and, so far as can be ascertained ever since the island was discovered, there has been no period of equal duration, in which so little rain fell, and in which floods, droughts, and sickness have been so prevalent, it may be interesting to enquire whether any local changes of a physical character have taken place, which might in any degree account for so unusual or it may be unprecedented occurrences."

"Now, the only known change, which would be at all likely to produce, or tend to produce any such effects, is the change which has been brought about in the condition of a large portion of the surface of the island by a rapid extension of population and agriculture, and a corresponding destruction of the primeval forests."

"There is a considerable variety of indigenous trees, several of which attain heights of from 30 to 40 feet or more, and which at one time afforded excellent timber. With these trees and a variety of shrubs and creeping plants, the island was at one time densely covered, except on the bare summits and steep rocky flanks of the mountains, and here and there where patches of savannah and some barren plains existed !'

"How many acres of these forests have been cut down, and how many still remain, are questions which cannot be fully answered, because no measurements have been made. We can only arrive at approximate estimates by considering the progress of population and agriculture."

"In 1764, the population of the island was 18,732, from which it rose to 59,000 in 1797, 158,462 in 1846, 183,406 in 1851, and 313,462 in 1861. When the epidemic broke out early in 1867, the population was about 340,000, or 455 to the square mile, which is a high rate."

"The progress made by agriculture during the last 20 years has been very great. Thus, the quantity of sugar (the only export,) made in 1845-46 was only 46,610 tons, whereas, in 1853-4 it was 90,746 tons, and 141,215 tons in 1862-63. From 1851 to 1856 the crop steadily increased; it then fluctuated, but, on the whole, increased up to 141,215 tons in 1862-63, which was the largest crop ever made. Since that time it has been decreasing."

"This rapid increase of population and produce, since 1851, is due to immigration from India and to the importation of guano. By introducing

Coolies to any desired extent, and by using guano in the damp soils in the interior of the island, it was thought that fortunes might be realized; and the wealth of the colony greatly increased; and so a vigorous attack was made upon the forests in all directions. Extensive tracts were brought under cultivation for the first time in Moka and Plaines Wilhelms on the table-land, and in the higher parts of Flacq, Grand Port, and Savanne, bordering on the table-land, which were the localities where the forests were most abundant. The yearly produce increased in all the districts, but more especially in those just mentioned. Thus, the sugar-produce of Savanne rose from 5,615 tons in 1852 to 13,000 tons in 1862, that of Flacq from 15,000 tons to 38,875 tons, and that of Moka from 800 tons to 17,563 tons in the same period."

"According to Blue-books for 1852 and 1864, there were 60,352 acres more in cultivation in the latter than in the former year in Flacq, Moka, Plaines Wilhelms, Grand Port, and Savanne, and the greater portion of that area had, previously to 1852, been in forest."

"But that was only a part of the clearings that took place. As the population and cane cultivation extended, buildings of every description (including many new sugar-factories,) and the consumption of fuel increased. The wood felled for agricultural purposes did not supply the demand. Proprietors of forests in high and remote parts of the island, where the climate was as yet too damp and rainy for the sugar-cane, also engaged in the work of destruction, partly because the wood fetched a high price, and partly because, seeing that the table-lands at lower levels were becoming productive, they believed that in course of time their land would also become fit for cultivation; for it was very well known and admitted that the climate became drier in proportion as the forests were cut down. In this way large tracts of forests have been either much thinned or entirely cleared in localities which have not been cultivated."

"Upon the whole, I think that at least 70,000 acres, or about one-sixth of the entire area of the island, have been denuded of forest, since 1852, and that, too, on the central and elevated parts, at or near the sources of rivers, and in the neighbourhood of swamps and marshes, as at the Mare aux Vakois, close to which sugar plantations have been lately commenced."

"It is difficult to say what is the extent of forest still remaining; only very small portions are intact. Altogether there may be 80,000 acres, of which a large part is in a state of decadence."

"*Effects of Denudation.*—Now, without entering into a discussion on the subject, it seems to me that the destruction of the forests in a tropical island like Mauritius, would be followed by a decrease of the humidity, an elevation of the temperature, and a diminution of the rainfall."

"With regard to the first of these probable effects, it requires no instrumental observations to show that the climate in the interior of the island is much drier now than it was some years ago. The inhabitants of Moka and the upper parts of Plaines Wilhelms, have had practical proof of the difference in the fact that before those districts were planted with canes, it was necessary to expose, at short intervals, clothes, books, furniture, &c. to sun and air, in order to protect them from mould."

"The change, in this respect, in the littoral and drier parts, has, of course, been less; but it seems to be appreciable even at Port Louis. Thus, the mean relative humidity there for periods of five years, since 1853, has been as follows:—

| Years. | Relative Humidity. |
|---|---|
| 1853-57 | 72·1 |
| 1858-62 | 73·1 |
| 1863-67 | 68·2 |

"The very marked decrease since 1862 cannot well be accounted for, except on the supposition that as the trade wind passes over the table land before reaching the Observatory, the effect of the clearings upon the humidity of the air, away to windward, has extended to Port Louis."

"Observations have not been made sufficiently long and regularly at any station in the interior, to show whether or not the temperature has increased where forest once existed. At Port Louis, the mean temperature in the shade for groups of five years, since 1853, has been as follows:—

| Years. | Temperature. |
|---|---|
| 1853-57 | 76·6 |
| 1858-62 | 77·0 |
| 1863-67 | 77·2 |

"These figures appear to indicate a slight upward tendency."

"I have already shown that the rainfall since 1861 has decreased."

"The vapour pressure has also decreased. Thus:—

| Years. | Vapour pressure. |
|---|---|
| 1853-57 | ·657 |
| 1858-62 | ·665 |
| 1863-67 | ·638 |

"I would submit, then, that the decrease of rainfall, humidity, and vapour pressure, and the occurrence of floods and droughts, since 1861, may, in some measure be due to the cutting down of the forests, which commenced on an extensive scale about 1852, was vigorously carried on till 1862, and is still being prosecuted, though to a smaller extent."

"The rainfall returns for 1867 have not yet been received; but I am informed that at Port Louis, for that year, the fall was 35·97 inches, which is much greater than the fall in 1866, but still considerably below the mean of the last fifteen years. It would appear also, that in the course of the present year (1868), there have been copious rains, and on one or two occasions heavy floods, which may yet be followed by corresponding droughts, as in 1865."

"With a view to elucidate still farther this interesting and important subject, I hope to have observations taken at localities, which, as far as possible, shall only differ with each other with respect to forest. As yet, we only know generally that the stations near the remaining forests are the rainiest, without being able to determine how much of the rainfall is due to forest, and how much to elevation and aspect."

"*Outbreak of Fever in 1867.*- There are some considerations which seem to indicate that the terrible fever which has lately been devastating the island, may be a consequence of the climatic changes, brought about either by the felling of the forests, or by some less probable cause."

"The fever, which is entirely local and non-contagious, was never before known in the island as an epidemic. Now, as has been stated above, at no former period, so far as can be ascertained, were floods and droughts so prevalent, and the annual rainfall so small, as during the five years which preceded the outbreak of fever."

"It is admitted by all that the fever is malarious. The conditions, therefore, which favour the production of malaria, must, one would suppose, have had greater play than formerly, and this seems to have been the case. The ponds, swamps, and marshes on the lowlands near the coast, which are supplied with water, not only by the rains that fall there, but by drainage and percolation from the more elevated grounds where the rains are heaviest, necessarily become more or less dry in periods of general drought, whilst in periods of heavy rain they overflow. On the 12th of February, 1865, all the low-lying grounds were swamped, and the swollen streams brought down much vegetable débris, which partially filled the ponds and lagoons. As the flood was followed in the course of the year by droughts, these organic deposits were partially laid bare. Somewhat similar floods took place in December of the same year. The following year (1866) was perhaps the driest ever known in the island, and it was soon after the close of that year when the ponds and streams had been exposed to a severe drought, and certain swamps and marshes been partially dried up, that the fever became so virulent as to attract general attention."

"But although it did not assume the same magnitude, it would appear that the fever broke out as an epidemic for the first time, after a less intense drought, early in 1866, if not in 1865, and that it did so in the very driest spot in the island, viz., Gros Cailloux, in close proximity to the lagoons and at a time when an attempt was being made to dry one of them up."

"Not only did the epidemic make its appearance in the driest spot, but it has throughout been confined to the driest parts, and till recently, to the littoral on the western side of the island, where the rainfall is much less than on the eastern side. There are marshes in other parts of the island, but they do not fall so low during droughts as those near Gros Cailloux and Port Louis on the west coast, the rainfall on the western slopes being always less than on the eastern."

"There is little doubt that the overcrowded and greatly neglected state of Port Louis and many other localities contributed very much to swell the mortality; but the determining cause of the outbreak of the disease seems to have been the altered hygrometric state of the island."

"If that is really the cause, and if the change in climate is due to denudation, it would seem that the principal calamities that have befallen the people of Mauritius are self-inflicted, and that the proper remedy is to restore, as far as practicable, certain portions of the forests of which this once salubrious and beautiful island has been deprived. With a view to the accomplishment of that desirable object, to which attention had in vain been long ago directed, by *Mr. Boulton* and other colonists, his excellency the Governor, *Sir Henry Barkly*, has appointed a Commission to report upon the whole matter."

"The copious rainfalls during the summer months of the present year may raise a doubt of the expediency of an enquiry. But it should be borne in mind that the summer rains are always excessive, when, as from December to May last, revolving storms are of frequent occurrence. Summers in which few hurricanes occur in the Indian Ocean, and the dry months of September to November, are the periods when the effects of denudation are likely to show themselves most prominently. Besides, the main question is not merely whether the annual rainfall is less than formerly, but also whether a change has taken place in its distribution, and whether the humidity has decreased."

The two following paragraphs are from an article on "Rainfall in the Mauritius," by *M. Connal, Esq., C.E.*, which also appeared in the *Proceedings of the (British) Meteorological Society:*

"The fact of districts being now complained of as *too dry for cane growth*, where positively there is still a rainfall *above that which other districts*, where once the cane was cultivated with perfect success, ever conceivably could have had (take the case of Beau Sejour and Gros Cailloux,) seems to me to suggest grave doubts as to whether diminution of rainfall be the true cause of the cane-growth decay."

"It is universally admitted that *diminution of dampness* in the atmosphere is one of the most immediate apparent effects of forest destruction. May it not be, that to this cause we must look for the cane-growth decay? If such be the cause, then obviously forest-planting in the immediate vicinity of cane-fields, not *summit forest-planting* alone would be the appropriate remedy and it would be to the individual interest of every planter, who had an estate going out of cultivation from "dryness," immediately to commence reforesting a portion of his land."

*(To be continued.)*

## A STEAMSHIP LINE BETWEEN NEW YORK AND DEMERARA.

The establishment of a steamship line between this port and Demerara supplies a want long felt, and will do much to increase our trade with that country. The success of such a line can hardly be doubted, especially as return cargoes of sugar can always be obtained in consequence of cane grinding continuing throughout the year, while in Cuba the grinding season extends only from December to September.

The steamship *Mandango* sailed from Atlantic dock on 13th November for Demerara, stopping at St. Thomas and Barbados, the first of the new line of steamships. The line will consist of the *Mandango*, *Lagos* and *Gunga*, and will be known as the Red Ball line. The *Mandango* is a first class iron propeller, of 1,200 tons measurement, and 270 horse power. She is bark rigged, and makes 12 knots an hour. She has a handsome saloon cabin, commodious family cabins and staterooms, and is fitted up with all the modern improvements for steamships. She has accommodations for 76 first class passengers. The *Mandango* has been employed as one of the Royal Mail line between Liverpool and the west coast of Africa. She came out from Dartmouth, England, to Barbados—3,600 miles—in fourteen days' running time. The passage from Demerara to New York occupied but eleven days, including stoppages at Barbados and St. Thomas. Captain Edward Spence is the commander. The loading and passenger agents are Messrs. E. E. Morgans Sons, and the ship's dock is at Drake's stores, Atlantic dock. The *Lagos* and *Gunga* will follow the *Mandango*.—*American Grocer.*

# ON THE MANUFACTURE OF SUGAR FROM THE SUGAR CANE, AND THE MACHINERY EMPLOYED THEREIN.

*Continued from page 512, vol. iv.*

## PART XII.

For the more perfect systems of sugar manufacture, such as the Demerara system, or the *triple effet,* or Concretor, or vacuum pan, a more perfect system of cleaning the juice is desired than that afforded by the usual defecation.

As explained in a former paper, subsidence is most generally employed where the Demerara system is in use, in order to remove any impurities which may have escaped removal in the defecators.

For subsidence, however, it is quite practicable to substitute filtration.

This operation may be effected either by means of bag-filters, or by filter-presses, or by char filters.

The bag-filter, though universally employed in English refineries, is but little used by planters, and deserves more attention from them than has hitherto been bestowed upon it.

It consists of a number of bags, made of a cotton fabric specially prepared for the purpose. These bags, which are open at the top and closed at the bottom, are usually about six feet long and fifty, sixty, or even seventy-two inches wide. They are thrust into strongly woven sheaths, of the same length as themselves, but open at the bottom.

Then the end of a nozzle is introduced into the mouth of the bag, and bag and sheath together are firmly attached to it. The nozzle in its turn is fastened to a perforated plate forming the bottom of a small tank, into which the liquor to be filtered runs, and the top of a chamber provided with closely fitted doors, in which the bags hang, and from the bottom of which the filtered liquor runs off. The perforations alluded to serve to admit the liquor through the nozzle into each bag.

It is evident that since a bag fifty or sixty inches wide is enclosed within a sheath, a very large filtering surface is thus compressed within a small space. The liquor entering the bags, gradually finds its way through them, running off bright and clear, the dirt being left behind in the bags.

The chamber containing the bags is kept heated by a jet of steam; this steam jet has a double object: first, it causes the liquor to run more freely through the bags; second, it has a tendency to prevent their becoming sour, which would, of course, be very prejudicial. When the bags are full of dirt, or show any symptoms of sourness, they are removed, taken out of their sheaths, and thoroughly washed. It is usual to have a double set of bags, so that one may be in use while the other is being washed, the same nozzles and filtering chambers serving for the two sets.

The filter-press, which, like the bag-filter, clears the liquor from impurities by filtering it through a linen or cotton fabric, is but little known in England and the English colonies, though it is almost universally employed on the Continent of Europe in the manufacture of beet-root sugar, and is also frequently made use of in Cuba.

In the bag-filter, the whole strain of the weight of the liquor being filtered, is borne by the filter bags and their sheaths; as any considerable pressure would burst these, it is only practicable to run the liquor through, giving but a few inches of head. In the filter-press, on the contrary, the filter-cloth rests upon a perforated plate, which relieves it from all strain, and allows the liquor to percolate through into the channels of a grooved plate, whence it flows away through a cock. Thus a considerable pressure may be applied to the liquor without fear of injury to the filter-cloths, and the dirt may thus be far more effectually consolidated. In the bag-filter, should a bag burst or be imperfectly tied, it is difficult to detect which bag is in fault, and to prevent the access of liquor to it; thus a burst bag necessitates the stopping of the filter and search for the defect, or otherwise the whole of the liquor is liable to be more or less dull and muddy.

In the filter-press, each pair of filtering cloths communicates with a separate cock. If one of them is imperfect, this is at once indicated by the liquor coming from that particular cock being muddy. This cock is shut off, and liquor then ceases to pass through the imperfect cloth, while the whole of the rest of the filter-press can go on with its work as usual, so that the defective cloth need only be replaced when the filter is stopped to have the dirt removed from it.

In the bag-filter the dirt must be removed from the bags by hand, while in the style of filter-press in most extensive use, it falls from its place as soon as the plates forming the apparatus are removed from one another far enough to let it pass.

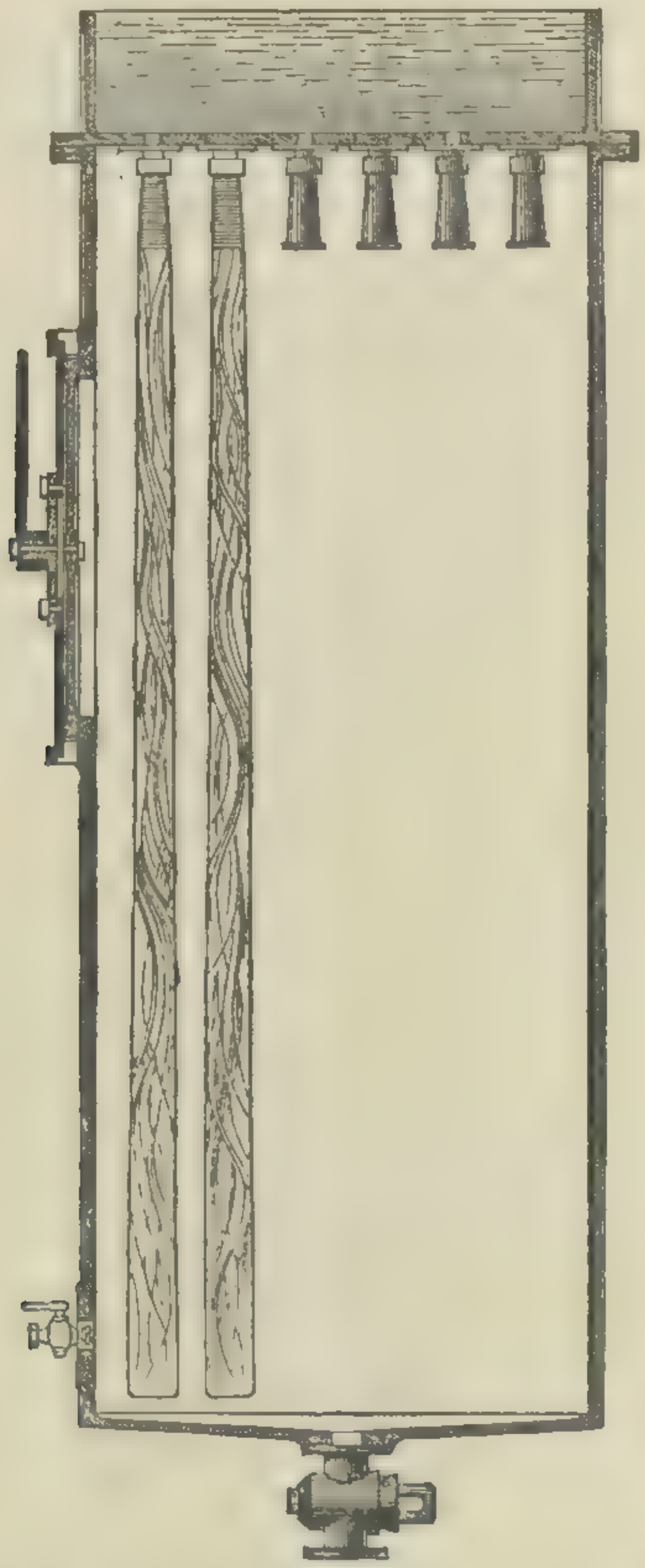
In the bag-filter the bags must be removed from the apparatus to be washed, and this is a troublesome and laborious operation; in the filter-press the filter-cloth may, if desired, be washed in its place by passing water through the apparatus.

The quantity of filtering-cloth employed in the filter-press is much less than that needed where bag-filters are used, the decrease in filtering surface being made up for by the application of pressure for forcing the liquor through. It is, however, necessary to have a *monte-jus* or a pump to furnish the required pressure, and these may often be dispensed with where bag-filters are employed.

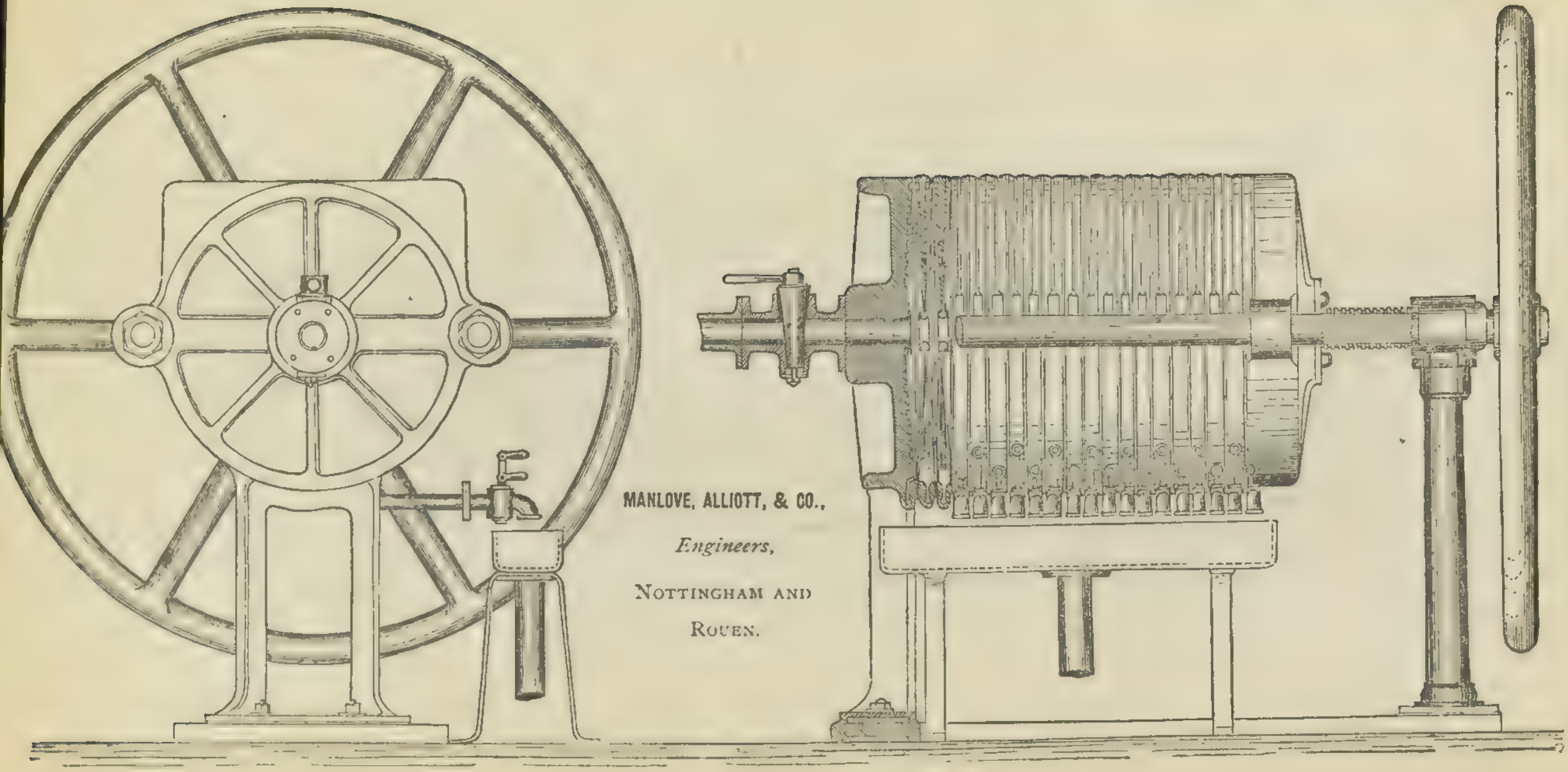
The filter-press which is perhaps most generally approved, is that patented by Messieurs Du Rieux and Roettger, of Lille, and manufactured by Messrs. Manlove, Alliott and Co., of Nottingham.

It consists of strong end framings, connected together by powerful wrought iron rods; upon these rods the filter-frames are supported by means of ears, which allow them to rest upon the rods, while at the same time they are free to slide backwards and forwards upon them. Each filter-frame in a filter-press consists of a plate of iron grooved on both sides and provided with a central hole, and with projecting flanges. All the grooves of the plates are in communication with a pipe closed by a cock, through which the filtered liquor can be run off.

Upon these grooves rest perforated plates which enter within the projecting flanges of the filter-frames, and upon these again the filtering-cloths, of sufficient size to cover these flanges, both being so arranged as not to close or interfere with the central openings in the plates.



It is evident that when two filter-frames are brought together, only their projecting flanges will touch; between these the filter-cloth will be nipped, the joint being made good by means of an indiarubber ring introduced for the purpose. Between the grooved plates of the two frames will be left a space corresponding with the depth of the flanges on the frames; into this space the liquor to be filtered is introduced. It enters the press by a central opening in the end frame work, and finds its way from filter-frame to filter-frame through central openings in these already described.



**MANLOVE, ALLIOTT, & CO.,**

*Engineers,*

NOTTINGHAM AND

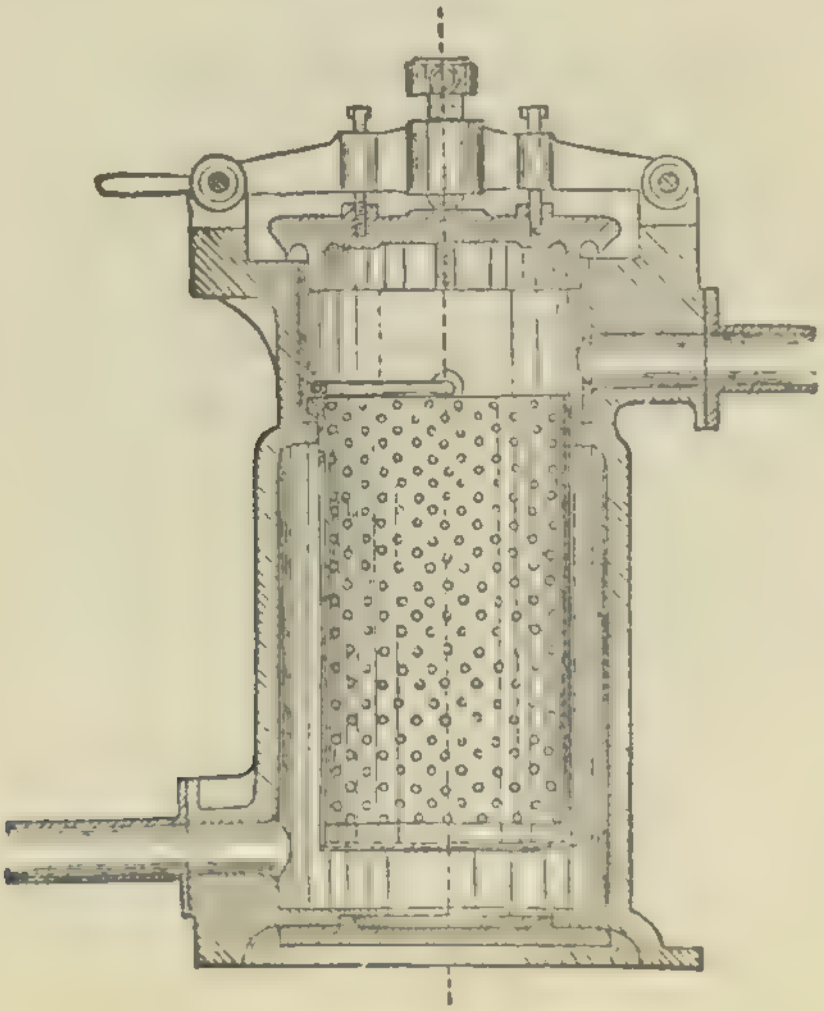
ROUEN.

From these spaces the liquor percolates through the cloth and perforated plates into the grooves already described, whence it can flow freely away, while the dirt gradually accumulates in the spaces between the frames until these are full.

The flanges of the frames are kept in close contact by means of a powerful screw attached to one end of the apparatus. As soon as the machine is choked by dirt this screw is slackened, and each frame may then be run a little distance back from its neighbour, so as to allow the round cake of dirt formed between the two to fall to the ground. When the dirt has thus been removed, the frames are again approached to one another, the screw tightened, and the press is ready either to be washed by having water run through it, or to be again used for filtering liquor.

Another description of filter-press is also sometimes used, in which a separate frame is introduced to contain the dirt; but as these presses require more labour to work them, and offer no corresponding advantage to the planter, we shall not enter into the details of their construction.

It is often useful to use, in conjunction with filter-presses, and between them and the feed, the apparatus shown, called a



"sifter;" this retains all grosser impurities which might interfere with the working of the press.

Neither subsidence nor filtration, whether through bag-filters or through filter-presses, has any power to decolorize the cane juice. These operations can only remove impurities mechanically suspended in the juice, and thus leave it clear and bright.

The third method of filtration to which we shall next have to allude, that through animal charcoal, has, however, a greater power; it can not only detain particles of foreign matter, but it can remove colour. Liquor which enters the charcoal filter dark-coloured and muddy, will issue from it, not only bright and clear, but also of much lighter colour. It is this property which renders animal charcoal so peculiarly valuable to the refiner; but the whole subject is so important that we must leave it to be treated in another paper.

*(To be continued.)*

## PURIFICATION OF CONDENSED WATER, TO BE USED FOR FEEDING STEAM BOILERS.

The water obtained by condensation in steam engines is generally mixed with the fatty matter, used for lubricating some parts of the machine, which is carried away by the condensed steam. The process patented by Messrs. Cail & Co., Paris, for separating the fatty matter, consists in collecting all such condensed water in a general receiver or reservoir, with which are connected two cisterns provided with means of agitating the water, such as an archimedean screw, or paddles, &c.

These cisterns are about three parts filled with this soiled water, to which a small quantity of petroleum is added, and then agitated with the water for five minutes; it is then allowed to stand about fifty-five minutes, when all the petroleum mixed with the fatty matter collects on the surface of the water, and can easily be separated.

From the observations of the patentees, the average amount of fat which is daily formed is about 2 decigrammes (3·088 grs.), or $\frac{1}{5}$ of a gramme per horse power per day, at the most 100 grs. per day for an engine of 100 horse power.

To ascertain if the petroleum has lost its action, about a quarter of a litre of the water is mixed with a few drops of caustic soda solution, and brought to boil. If after a few minutes' boiling a scum is formed, the petroleum has lost its action, and more must be added.

If required, the used petroleum can be recovered by distillation, leaving the fatty matter as a residuum.

## JOHORE, AS A FIELD FOR SUGAR CULTIVATION.

By J. Meldrum.

The territory of Johore contains about ten thousand square miles, and for the most part is covered with virgin forest; there is some undulating land near the sea coast, a few hills, the nearest being Gunang Pulai, upwards of 2,000 feet high—at the base of which large level tracts of land exist, well adapted for the cultivation of the sugar cane, and other tropical articles of commerce. The distance from Singapore to New Johore is 16 miles, and may be reached by a good road, or by water, in which case the distance is about 30 miles. The centre of the territory is about lat. N. 2° 0′, and long. E. 103° 30′, bounded by the Straits of Malacca on the west, the China Sea on the east, the rivers Mam and Indan on the north, and the old straits of Singapore on the south. Through this strait, also called the Tambroh Channel, ships of the old East India Company occasionally passed on their way to China. His Highness the Maharajah of Johore, K.C.S.E.; K.C.C.E., &c., is at present constructing a line of railway to open up the country, and along this line much fertile land exists, excellently well adapted for the cultivation of the sugar cane. Land can be had for a merely nominal rent. Labour is abundant and cheap. Thousands of Chinese Coolies annually arrive at Singapore seeking employment; last year two-thirds of them came over to this territory and engaged with gambier and pepper planters. With the exception of tapioca, now being extensively planted, gambier and pepper are the only articles cultivated at present.

There are no long droughts, and the country abounds in rivulets, streams of clear and sweet water. Taxes are light; food abundant and cheap. Timber trees of superior quality are in great plenty. Saw mills exist, and are in operation at New Johore. No epidemics are known. Neither the typhoons of the China Seas nor the cyclones of the Bay of Bengal affect these favoured regions. Singapore not only affords a ready market for all sorts of produce, but facility for obtaining freight to all parts; this in itself is a great advantage.

The Tambroh Channel forms an excellent land locked harbour and vessels of the largest class can load alongside the wharves of the Johore steam saw mills, and similar wharves or jetties could be erected at any point in the channel at small cost. There are no harbour dues whatever, Johore being a free port.

Canes, planted in the gardens of the Malays and about the Chinese gambier plantations, thrive luxuriantly, and if encouragement existed, the supply of cane would be forthcoming, so that a central sugar factory could be established with good prospects of success. His Highness the Maharajah is anxious to develop the resources of his country, and is willing to give every facility to any one desirous of settling on his territory. He has always been on friendly terms with the British Government.

From the above sketch it will be seen that the advantages are many and great, and Mr. Wray, an authority in sugar planting, in speaking of the Straits says: "If the Straits planter will only avail himself of the several suggestions herein made, there can be no doubt that he can produce sugar at a rate as cheap as (if not cheaper than) any planter in the world."

*Johore, Barhu, November,* 1872.

## THE CONTINENTAL BEET SUGAR CROP.

The latest accounts of the beet sugar manufacture show no improvement, the same mild weather and rain continue, and the roots suffer considerably from sprouting and putrefaction. Dry and frosty weather is required; but it is too late for the evil to be more than very partially remedied; should favourable weather now appear, it could only influence a small portion of the crops. Many factories cannot house their supplies, and are besides short of limestone, coke and coals. The result will be a delay in the manufacture, which in some parts will be further retarded by the difficulty of gathering in the last crops of the roots.

In a certain number of factories the rasping will be finished by the end of the month (December), others will have to work longer than they anticipated, their supplies having exceeded their expectations. There is only a short time left for gathering the beets which are yet in the fields; so late a gathering, which can only be explained by the mildness of temperature and the difficulty in carting the roots, has never been known before. There will be in some parts a considerable increase in the quantity and weight of the crop, which will in some degree compensate for the great loss in sugar which the beet has suffered in the pits (*silos*). This circumstance alone will allow of the production of sugar (in France) reaching 350,000 tons, a figure at which we yet place it.

There is no improvement in the accounts from Belgium, Austria and Germany; in these countries, as in France, complaints are made of the beets preserved in the pits, which complaints appear to be general in Europe, with the exception, at least according to the statement of M. Licht, of Russia and Poland. A correspondence noted in our last number, shows however that even in the Governments of Kief and Podolia the beet in pits does not keep well. These exceptional circumstances have caused M. Licht to reduce his estimate of the present season's Continental sugar production to 1,010,000 tons, from 1,040,000 tons as given in November.—*Journal des Fabricants de Sucre.*

## ON THE INFLUENCE OF TEMPERATURE IN DETERMINING THE DENSITY BY MEANS OF AREOMETERS.

It is known that the determinations of density are wrong when the liquid possesses a temperature different from that at which the instrument was made. In consequence of this difference, a series of experiments were made, for which a standard liquor of molasses of 42·11° Beaumé, temperature of 15° C. was used, the results of which are represented in the following table :—

| Temperature. | |
|---|---|
| 0° Cent. | 42·92° Beaumé. |
| 10° „ | 42·30° „ |
| 15° „ | 42·11° „ |
| 20° „ | 41·95° „ |
| 25° „ | 41·73° „ |
| 30° „ | 41·53° „ |

From this, it appears that the differences are not proportionate with the temperatures; they are more important between 0° and 10° C., than between 20° and 30° C. As a rule it may be admitted, that with each degree of difference in heat, the indications of areometers vary $\frac{1}{20}$ of a degree Beaumé.—*La Sucrerie Indigène.*

## THE *NEW* OLIVE-SHAPED BEET ROOT.

The improvement of the beet root has for a long time been the object of general attention on the part of practical beet-root growers. Every possible variety has been grown, and the culture of this plant has reached such a degree of perfection that its higher development could almost be dispensed with. All endeavours are now directed to the production of a root uniting in itself every desirable quality. The beet should only have one root, so that it is easily taken from the ground, it must keep well, and give the highest yield in sugar. Experience proves that deep-rooted beets are far more nutritious, and richer in sugar than those which grow above the soil.

The olive-shaped beet grows half its length in the soil, and is therefore rich in sugar; it has small leaves, and can on this account be sown close, and thus a larger yield per acre obtained than of ordinary kinds; its flesh and stems are white, and from its regular olive shape it is easily taken from the soil; it grows only one root, and does not become hollow, like other beets, during the winter.

Even during unfavourable seasons this variety of beet root gives favourable results, and has on that account attracted the general attention of the French beet-root cultivators.

## GUANAPE GUANO.

After the exhaustion of the depôts of the guanos of the Chinchas Islands (Peru guano), the Peruvian Government has brought into the market a new guano, found on the Island of Guanape, which is called Guanape guano; it is of the same colour and appearance as the Peruvian guano, but differs essentially in active substances, particularly in nitrogen, as can easily be seen from the following comparative statement:—

| | Guanape Guano. | | Peru Guano.<br>Average from 1859-72. |
|---|---|---|---|
| Water ................ | 21·63 °/₀ | .... | 15·80 °/₀ |
| Nitrogen, total.......... | 9·39 ,, | .... | 13·64 ,, |
| Phosphoric acid, total.... | 13·39 ,, | .... | 13·23 ,, |
| Sand.................. | 6·30 ,, | .... | 3·23 ,, |

This comparison shows that the Guanape guano is less valuable than the old Peruvian guano, as it contains more water and sand, and much less nitrogen. Recently made analyses have indicated even lower figures than the above, principally by higher percentage of acid and nitrogen, so that the value of Guanape guano, from its changeable composition, becomes still more questionable.—*Zeitschrift fur Zuckerindustrie.*

# RESEARCHES ON THE PART WHICH SULPHUROUS ACID PLAYS WHEN EMPLOYED FOR THE SACCHARIFICATION AND SUBSEQUENT ALCOHOLISATION OF GRAIN,

ACCORDING TO A NEW METHOD.

BY V. HEMILIAN AND N. MELNIKOFF.

*(From the Chemical News.)*

During the last few years, a process has been introduced in the distilleries of Russia and Southern Germany, Bohemia, and other portions of the Austro-Hungarian Empire, which is considered by practical distillers to increase the yield of alcohol obtainable from grain, including maize, and which consists in the use of a weak solution of sulphurous acid when applied during the diastatic saccharification.

The raw grain and malt, previously ground to a fine powder, are macerated for from five to six hours in a cold solution of sulphurous acid, after which the mixture is heated to from 70° to 75°, and treated as usual. While there is no doubt that this practice is really good, the action of sulphurous acid on the substances capable of yielding alcohol has never been scientifically elucidated; we have made researches relative to this action, and here publish the principal results of our experiments.

In the first place, we have found, by a series of experiments, that sulphurous and other acids, employed in small quantities in practice, have the effect of very perceptibly diminishing the saccharifiant power of diastase, and, as a consequence of the application of the new method of saccharification, the action of a portion of the malt employed is rendered useless; but, on the other hand, our experiments have proved that sulphurous acid, applied in quantities to be hereafter indicated, renders the starch of the meal, when macerated in it for a long time, more fit for conversion into glucose. It is probable that sulphurous acid, during the process of maceration, dissolves slowly the gluten and other albumenoid substances which envelope the starch in the meal, and thus the immediate contact of the starch granules with the solution of the diastase is promoted during the saccharification.

The effect produced by the action of the sulphurous acid consists, therefore, in the difference of the two opposite actions, one of which is injurious to alcoholisation, by decreasing the saccharifiant power of malt, while the other favours a more complete interversion of the starch of the substances employed. This difference, which determines the increase in the quantity of glucose, depends directly on the duration of the cold maceration, and on the quantity of sulphurous acid employed. The largest quantity of glucose is obtained by causing the cold maceration to continue for five or six hours with a solution containing from 0·1 to 0·13 per cent. of the quantity of malt and meal used.

When the duration of the cold maceration is prolonged, and the quantity of sulphurous acid diminished, the quantity of glucose obtained is increased to its maximum. When the maceration in cold water, without sulphurous acid, is continued for eighteen hours, the result is equal to that obtained by the use of macerating with cold sulphurous acid solution; but maceration in cold water only is sure to bring on acidification and incipient putrefaction, which is not the case when sulphurous acid is present. If, on the other hand, the quantity of sulphurous acid is increased, and the time of cold maceration decreased, the quantity of glucose obtained rapidly decreases, because the injurious influence of the sulphurous acid upon diastase then begins to predominate over its favourable action upon the meal.

The increase in the yield of glucose, under the action of sulphurous acid and the most favourable conditions, is found to vary from 2 to 3 per cent of the weight of the grain employed. No sulphuric acid is formed during the cold maceration alluded to; the sulphurous acid forms, with the macerated materials, combinations from which, by the application of mineral acids, the sulphurous acid is set free without simultaneous precipitation of sulphur, so that no formation of hyposulphites takes place. The colouring matter of malt is, moreover, destroyed by the cold maceration with sulphurous acid; and, since we have found that the combinations formed by sulphurous acid during the cold maceration do not perceptibly injure the saccharifiant property of diastase, we propose the following modification in the application of this method. The meal only, without malt, is macerated in the cold with the solution of sulphurous acid of the strength above mentioned, and then heated to 50°, so as to volatilise any free sulphurous acid. The malt is next added, and the mixture, being all the time well stirred, is heated to from 70° to 75°, these temperatures being best suited for saccharification. As regards the action of sulphurous acid upon the process of fermentation, comparative experiments have proved that this acid, in free state, even in so small a quantity as 0·2 per cent. of the sugar, very perceptibly hinders the alcoholic fermentation, which is rendered very slow, while the combinations formed by the sulphurous acid during the maceration, do not at all effect the ordinary course of the fermentation, which continues regularly until all the glucose is spent. During the fermentation of the wort obtained by the new method, and application of sulphurous acid, sulphuretted hydrogen is evolved in small quantity mixed with carbonic acid, while, in the fermenting liquid, sulphur compounds are formed which it would be very interesting to study more minutely. It is very important, for practical purposes, to know that, in wort fermenting under the conditions just mentioned, not half as much free acid is formed as in the fermentation of grain, malt, and meal under the ordinary conditions. The utility of the sulphurous acid process is rendered very apparent when it is borne in mind that the free acids alluded to are formed at the expense of alcohol, while, at the same time, by the decrease of acids the nutritive value of the spent wash is rendered greater, and its consumption by cattle improved because it is rendered less injurious to health.—*Moniteur Scientifique.*

## NEW PATENTS.

1171. J. Barrow & C. J. Crosfield, Liverpool. *Utilising certain saccharine syrups.* Dated April 19th, 1872.

The syrups to be utilized are those given off through centrifugal machines. The object is to separate the small crystals by a direct process. Filtration through textile or porous fabrics is employed. The apparatus consists of a number of frames, fitted with the filtering fabric, secured between moveable followers. The syrup is forced through the fabric by a pump, in this way leaving the small crystals on the inner side, while the thin solution is allowed to flow away.

1350. W. M. Brown, 38, Southampton-buildings, Chancery-lane, London. *Centrifugal machines.* Dated May 3, 1872.

The class of centrifugal machines wherein a certain amount of vibration or gyration is permitted, so that the basket may accommodate itself to the inequalities of the load. The step or lower support is suitably suspended by rods from the curve or outer case, or the curb and step together are suspended by rods from a suitable framing. The upper bearing of the shaft is fitted with a laterally yielding bearing to give the necessary play required from the movement of the lower support.

1394. F. L. H. Danchell, Horwich, Lancashire. *Filtering medium.* Dated May 7, 1872.

A homogeneous combination of carbonaceous matter with certain mineral matter. The proportions of the carbonaceous and mineral substances are such that the first should constitute from 10 to 15 per cent. on the whole after charring, and the mineral the rest.

1437. J. V. P. Lagrange, 23, Boulevard de Strasbourg, Paris. *Treatment of saccharine juices and syrups.* Dated May 11, 1872.

Application of baryta to the elimination of sulphates in sugar making and refining either separately or simultaneously in the hydrate state with tribasic phosphate of ammonia.

1477. A. Fryer, Manchester. *Treatment of cane sugar.* Dated May 15, 1872.

Improvements in the treatment of cane sugar, by which a better quality and a larger yield is obtained than by the ordinary methods; also to improvements in machinery or apparatus to be employed in connection with such treatment.

3588. A. V. Newton, Chancery-lane, Middlesex. *Improvements in the manufacture of sugar, and in apparatus to be used therefor.* A communication from S. Dod, Havana, Cuba. Petition recorded November 28, 1872.

## COLONIAL EXPORTS.

*(From Licht's Monthly Circular.)*

### MAURITIUS.

| FROM 1ST AUG. TO 15TH OCT. | 1872-73. | 1871-72. | 1870-71. |
|---|---|---|---|
| | Tons. | Tons. | Tons. |
| To England | 7,805 | 8,775 | 2,777 |
| ,, France | 5,385 | 6,692 | 2,159 |
| ,, Australia | 9,940 | 4,268 | 6,736 |
| ,, New Zealand | 1,669 | 1,056 | 720 |
| ,, Cape of Good Hope | 324 | 130 | 814 |
| ,, Bombay | 561 | 9,007 | 7,211 |
| ,, Other Ports | 622 | 1,188 | 148 |
| Total | 26,306 | 31,116 | 20,565 |

### HAVANA AND MATANZAS.

| FROM 1ST JAN. TO 3RD NOV. | 1872. | 1871. | 1870. |
|---|---|---|---|
| | Tons. | Tons. | Tons. |
| To Great Britain | 140,949 | 64,396 | 174,171 |
| ,, United States | 208,967 | 176,510 | 180,495 |
| ,, Spain | 37,151 | 45,060 | 57,812 |
| ,, France | 21,835 | 11,080 | 43,960 |
| ,, Northern Europe | 12,679 | 8,812 | 10,661 |
| ,, Southern Europe | 960 | 548 | 3,410 |
| ,, Other Ports | 5,075 | 3,284 | 8,096 |
| Total | 427,616 | 309,690 | 478,605 |
| Stocks in Havana and Matanzas | 25,714 | 33,454 | 22,284 |

### REUNION.

| IN THE SEASON OF | 1871-72. | 1870-71. | 1869-70. |
|---|---|---|---|
| | Tons. | Tons. | Tons. |
| To Nantes | 8,257 | 7,188 | 15,020 |
| ,, Marseilles | 1,804 | 2,500 | 4,527 |
| ,, Belle-Isle (or order) | 19,865 | 7,197 | 16,606 |
| ,, Cadiz | 2,595 | 987 | 1,516 |
| ,, Australia | 420 | 5,661 | 4,852 |
| ,, Persian Gulf | — | — | 134 |
| ,, Mauritius | 160 | — | — |
| Total | 33,101 | 23,533 | 42,655 |

### Stocks of Sugar in the Chief Markets of the World on the 1st November for Three Years, in thousands of tons, to the nearest thousand.

| | 1872. | 1871. | 1870. |
|---|---|---|---|
| Great Britain | 169 | 129 | 165 |
| France | 76 | 55 | 57 |
| Holland | 29 | 28 | 23 |
| Germany (Zollverein) | 15 | 16 | 19 |
| Six other *entrepôts* | 7 | 6 | 4 |
| Total in Europe | 296 | 234 | 268 |
| United States | 43 | 96 | 82 |
| Havana and Matanzas, 3rd Nov. | 26 | 33 | 22 |
| Total | 365 | 363 | 372 |

### Consumption of Sugar in Europe and the United States, for Three Years ending 31st October in thousands of tons.

| | 1872. | 1871. | 1870. |
|---|---|---|---|
| Great Britain | 704 | 679 | 690 |
| France | 237 | 290 | 321 |
| Germany (Zollverein) | 215 | 228 | 216 |
| Holland | 29 | 25 | 30 |
| Six other Countries | 86 | 118 | 106 |
| Total in Europe | 1,271 | 1,340 | 1,363 |
| United States | 591 | 508 | 472 |
| Total | 1,865 | 1,848 | 1,835 |

### Estimated Crop of Beet Root Sugar on the Continent of Europe, for the ensuing Season, compared with that of the three previous Seasons.

*(From Licht's Monthly Circular.)*

| | 1872-73. | 1871-72. | 1870-71. | 1869-70. |
|---|---|---|---|---|
| | Tons. | Tons. | Tons. | Tons. |
| France | 345,000 | 335,351 | 289,084 | 289,324 |
| Germany (Zollverein) | 255,000 | 189,166 | 262,986 | 217,192 |
| Austro-Hungary | 167,500 | 161,526 | 182,280 | 151,354 |
| Russia and Poland | 135,000 | 90,000 | 135,000 | 132,500 |
| Belgium | 75,000 | 72,236 | 55,739 | 43,552 |
| Holland and other Countries | 32,500 | 25,000 | 17,500 | 12,500 |
| Total | 1,010,000 | 873,279 | 942,589 | 846,422 |

## SUGAR STATISTICS—GREAT BRITAIN.

To 14th December, 1872 and 1871. In Thousands of Tons, to the Nearest Thousand.

| | STOCKS. | | | | | | IMPORTS. | | | | | | DELIVERIES. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | London. | Liverpool | Bristol. | Clyde. | Total, 1872. | Total, 1871. | London. | Liverpool | Bristol. | Clyde. | Total, 1872. | Total, 1871. | London. | Liverpool | Bristol. | Clyde. | Total, 1872. | Total, 1871. |
| British West India | 19 | 2 | 2 | 18 | 41 | 23 | 86 | 13 | 14 | 59 | 172 | 205 | 79 | 12 | 14 | 46 | 150 | 205 |
| British East India | 10 | 3 | .. | .. | 13 | 8 | 21 | 8 | .. | .. | 29 | 15 | 13 | 8 | .. | .. | 22 | 24 |
| Mauritius ...... | 4 | 1 | 2 | .. | 7 | 5 | 17 | 5 | 17 | 8 | 46 | 23 | 15 | 4 | 17 | 10 | 46 | 22 |
| Cuba .......... | 4 | 1 | .. | 11 | 17 | 11 | 8 | 15 | 26 | 67 | 115 | 54 | 8 | 14 | 25 | 62 | 109 | 54 |
| Porto Rico, &c. .. | 2 | 3 | .. | 1 | 6 | 5 | 5 | 20 | 1 | 8 | 34 | 27 | 4 | 18 | 1 | 7 | 31 | 30 |
| Manilla & Java .. | 20 | 4 | .. | 3 | 27 | 21 | 35 | 15 | 2 | 16 | 68 | 49 | 28 | 20 | 2 | 14 | 64 | 69 |
| Brazil .......... | 2 | 12 | .. | 5 | 19 | 15 | 9 | 51 | 9 | 22 | 91 | 61 | 8 | 47 | 10 | 22 | 86 | 61 |
| Beetroot, &c. .... | 5 | 2 | 2 | 10 | 19 | 16 | 23 | 12 | 8 | 49 | 92 | 140 | 23 | 12 | [illegible] | 44 | 87 | 140 |
| Total, 1872 .. | 67 | 28 | 6 | 48 | 149 | 103 | 205 | 139 | 77 | 227 | 649 | 574 | 178 | 137 | 76 | 204 | 595 | 604 |
| Total, 1871 .. | 41 | 28 | 3 | 31 | 46 increase | | 189 | 118 | 59 | 208 | 75 increase | | 217 | 123 | 60 | 203 | 9 decrease | |

# THE SUGAR MARKET IN 1872.

The year opened with a dull market for all descriptions of sugar, and during the months of January and February prices declined considerably, in consequence of increased imports and a falling off in deliveries; but, as the year advanced and stocks in the United Kingdom became much lower than for several previous years, more activity was manifested, and by the end of April the depression in prices had been nearly recovered. At this time there was every prospect of greatly diminished supplies of raw sugars for this country, inasmuch as the very inferior yield of the last Continental beet crop not only prevented exports of that description of sugar, but also tended to divert cargoes of colonial sugar intended for the United Kingdom to French and German Ports.

For the first six months of the year, stocks showed a continual comparative decrease as compared with the two previous years, and in the middle of June stocks of raw sugar at the four ports were more than 50,000 tons below those of the same date in 1871, and nearly 100,000 tons less than at the corresponding period of 1870. About this time prices reached the highest point of the year; No. 12 Havana afloat being quoted at 31s. 6d. per cwt.; the average duty paid price of refining qualities of British Plantation was 33s., and that of common refined lump 42s. 6d. per cwt. in London.

These comparatively high prices attracted supplies from unexpected quarters, and, consequently, a remarkable reaction took place. During the month of August alone there was an increase in the imports of 40,000 tons over those of the previous year, and by the end of that month the stocks of raw sugar were 11,000 tons in excess of those of the same date in 1871. As a necessary consequence prices of all descriptions were proportionately depressed. No. 12 Havana declined fully 4s. per cwt., and the average reduction was from 3s. to 3s. 6d. per cwt., to the lowest point of the market in September.

During the last three months of the year, the imports and stocks as compared with 1870 and 1871 continued to increase, and on the 21st of December imports of raw sugar showed an excess of 50,000 tons over those of the former year and of 78,000 tons over those of the latter. Stocks were then 6000 tons above those of 1870 and 47,000 tons in excess of those in 1871 at the same date. Deliveries of raw sugar, for the year, show a decrease of 7000 tons compared with those of 1871.

The London market closed with some firmness in consequence of the operations of the Scotch refineries being temporarily restricted, but during the last few weeks there was scarcely any variation in prices. The latest quotations were, for No. 12 Havana afloat 28s. per cwt.; for Cuba Muscovado, 25s. to 25s. 6d. per cwt.,—3s. to 3s. 6d. per cwt. lower than at the close of the year 1871. In lower qualities of raw sugar the reduction is still greater as compared with the same period, middling to good Bahia being quoted at 21s. to 22s.; and good to fine Pernambuco 23s. to 24s. per cwt. The average duty paid price of British plantation is 28s. 6d.; that of common refined lump, 39s. to 39s. 6d. per cwt.

Stocks of raw sugar in the United Kingdom are now higher than at the corresponding period of any former year since 1866; the supplies for this country now afloat are also large for this season of the year. On the other hand, stocks in the United States are considerably smaller than usual.

As regards the future; although the continental beet sugar production is, owing to unfavourable weather, likely to be rather less than was at one time anticipated, yet the most moderate estimate places it at 130,000 tons above that of last season. Favourable accounts of the coming crop continue to be received from Cuba; it is possible that there may be a slight deficit in the yield in Mauritius and in several of the British West India Islands, but this will probably be more than compensated by increased or fully average crops from Brazil, Java, Porto Rico, and some other colonies.

THE
SUGAR CANE.

No. 43. FEBRUARY 1, 1873. Vol. V.

☞ The writers alone are responsible for their statements.

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# ON SUPERPHOSPHATES—THEIR ADULTERATIONS AND VALUATION.

By J. Emerson Reynolds, M.R.C.P.,
*Professor of Analytical Chemistry to the Royal Dublin Society, Keeper of the Minerals, &c.*

(Continued from page 16.)

Having pointed out the manner in which the table of equivalents can be used for the purpose of obtaining an accurate expression for the relative total values, we may discuss the data, and endeavour to deduce standards for the two classes of superphosphates.

*Mineral Superphosphates.*—With the exception of Nos. 1 and 2, all those manures whose analyses are given were sold at £6 10s. per ton to the farmer. By adding in each case one-thirteenth to the number found for Nos. 1 and 2 on the Royal Dublin Society's scale, we can consider them as if sold for £6 10s. per ton each—and therefore compare their number with those given for the remaining samples.

In the following table these corrections have been made :—

| Number. | Sold to Farmer at | Degree on R.D.S. Scale. |
|---|---|---|
| 1 | £6 10s. | 612° |
| 2 | 6 10s. | 644° |
| 3 | 6 10s. | 630° |
| 4 | 6 10s. | 615° |
| 5 | 6 10s. | 520° |
| 6 | 6 10s. | 509° |

Dismissing Nos. 5 and 6 as being of inferior quality, we have four of these superphosphates, made by different manufacturers, sold at the same price, and approaching closely to each other in the number of degrees reached on the Royal Dublin Society's scale. They are undoubtedly useful fertilisers, and their mean number agrees with the mean afforded by my own analyses of corresponding samples. We are therefore in a position to fix our standard of value for a mineral superphosphate as follows:—*Samples marking 620° on the Royal Dublin Society's scale above described, should not cost the farmer more than £6 10s. per ton.*

From the foregoing we at once deduce the simple and convenient statement, that a manure marking 600° R.D.S. is worth just *six guineas* per ton.

A single example of the use that I make of this "Royal Dublin Society's Standard Mineral Superphosphate" will suffice. Let us suppose that a farmer purchases a sample of mineral superphosphate at £6 10s. per ton, and that on the discussion of its analysis it affords the same number as No. 6, namely 509° on the R.D.S. scale, ; we at once report the manure to be value for only £5 6s. 8d.

The money value obtained on the old plan, and actually attached to No. 6 by the analyst was £6 7s. per ton. The latter estimation would, therefore, indicate to the purchaser at £6 10s. that he obtained fair value for his money, though really paying about £1 per ton too much. My system at once detects and measures this serious reduction in value.

*Bone Superphosphates.*—In these cases the equivalent number "8" of a bone phosphate (see table) has been used for dividing the insoluble phosphate; the number 13 being used for the same purpose in discussing the analyses of the mineral superphosphates. The superiority of undissolved bone phosphate over the mineral phosphate in the same condition being thus fully and fairly recognised, the degrees on the R.D.S. scale afforded by the bone manure of course have the same meaning as when deduced from the analysis of a mineral superphosphate. Our standard mineral superphosphate, therefore, measures the value of a bone manure.

If, then, the former is only value for £6 10s. per ton, when it marks 620° on the R.D.S. scale, the bone manure is only value for £8 per ton when it reaches 763° on the same scale.

Having deduced our standard from the previous enquiry, we may now ascertain how far the result is confirmed on the discussion of the above given analyses of bone superphosphates.

We first have to raise the equivalent of No. 10 from 573° to 679°, being in the ratio of £6 15s. to £8, and then tabulate the numbers as before, thus:—

| Number. | Sold to Farmer. | Degree on R.D.S. Scale. |
|---|---|---|
| 7 | £8 | 883° |
| 8 | do. | 537° |
| 9 | do. | 600° |
| 10 | do. | 679° |
| 11 | do. | 655° |
| 12 | do. | 811° |

Nos. 7 and 12 are derived from vendor's analyses, the rest from those of purchasers. No. 8 is so obviously a very inferior manure that we may dismiss it from consideration. Then, taking the average of the remaining five samples we get at the mean result on the R.D.S. scale 745°. We are therefore fully justified in adopting as a fair standard that which we have deduced from other considerations, namely, *763° on the Royal Dublin Society's scale for a sample of bone superphosphate costing the farmer not more than £8 per ton.*

Having, I hope, shown that the existing system of valuation of superphosphates may be replaced with advantage by another capable of yielding results of higher accuracy and practical value, and having fixed certain standards, by reference to which these artificial manures can be adjudicated upon with fairness alike to the vendor and the farmer; I ought to give notice that all superphosphates sent to the Royal Dublin Society for analysis must now be valued on the above plan.

In concluding this paper I may venture to express the opinion that much public advantage would accrue if the Royal Dublin Society offered some inducement to dealers in superphosphates to compete, on the understanding that the best sample offered at a given price to the farmer should be used as a standard for reference during the season immediately following the competition. However, until some such plan is adopted, I venture to think we may fairly rest content with the standards I have now endeavoured to fix.

## ON THE MANUFACTURE OF SUGAR FROM THE SUGAR CANE, AND THE MACHINERY EMPLOYED THEREIN.

*(Continued from page 43.)*

### Part XIII.

We have now, as intimated in our last paper, to take up the subject of filtration through animal charcoal. It is upon this process that the refiner relies for transforming the scorched and blackened sugars which he but too often receives from the planter into the white and blooming crystals which he offers to his customers. Animal charcoal is prepared by calcining the bones of animals in vessels closed so as to exclude the air. The bones are usually boiled some hours before they are calcined, so as to extract the fatty matters from them, since these have a value of their own, and are almost totally lost (being given off in the form of gas during the process of calcination), if not thus separated.

The fatty matter having thus been extracted, the bones are next placed in pots made of fireclay or iron. These pots are arranged in rows one above another in a furnace, the mouth of each pot being closed either by another pot standing upon it, or by a cover. The fire is then lighted, and the whole furnace brought gradually up to a red heat, at which temperature it is maintained for about eight hours, the time usually necessary to complete the calcination. During the process various gases are given off, which take fire and aid in maintaining the necessary heat; when these cease to be evolved, the operation of calcination is complete. It is usual to allow the whole furnace to cool down before withdrawing the pots, and with the arrangement described it is almost impossible to avoid this, though such a course is plainly very wasteful of fuel. In consequence of the loss thus occasioned, bones have sometimes been calcined in retorts similar to those used in making gas, and so arranged that the bones could be introduced into the retorts, and taken out of them again without removing the retorts from their places, or allowing the furnace to cool down. In any case, however, the calcined bones must be protected from the air while cooling, otherwise the carbon contained in them will be destroyed, and the charcoal thus rendered useless.

After cooling, the bones are passed through a mill to reduce them into a coarse powder, and are then passed through sieves, so that the grains of the same size may be kept together. That portion which is reduced to dust is of much less value than the larger grains, while on the other hand too large pieces are not admissible and must be reground.

Charcoal appears to depend for its decolorizing effects upon the quantity of carbon present in it, and upon the state in which the carbon is found, its activity increasing in proportion as it is less compact, less hard, less brilliant, more porous, and more finely divided, though merely mechanical subdivision has no effect upon it.

In animal charcoal the molecules of carbon are found in the condition in which they are most active, and it is for this reason that this charcoal is so much more powerful than any other in its decolorizing effects.

Since it is upon the carbon that the charcoal depends for the greater part of its useful effects, it is usual in purchasing it to test what proportion of this material is present in it, and thus to determine its commercial value.

It is not known in what exact way the carbon acts upon the colouring matter which it extracts; whether it simply detains it mechanically, or combines with it chemically, or has the property of condensing it upon its surface or within its pores, in the way in which spongy platinum acts in absorbing hydrogen gas, is uncertain, though it is probable that some power is present over and above that of mere mechanical detention.

In addition to absorbing colouring matter, animal charcoal has also the power of taking up any excess of lime, any free acid, any nitrogenized matters, or any salts (with some exceptions) which may be present in the juice, whilst upon the sugar itself, its action appears to be almost if not altogether *nil.*

It will readily be understood that the above-named properties render animal charcoal most valuable in purifying and promoting the crystallization of sugar; but in order to obtain these advantages in their entirety, it is necessary to use the material with no sparing hand.

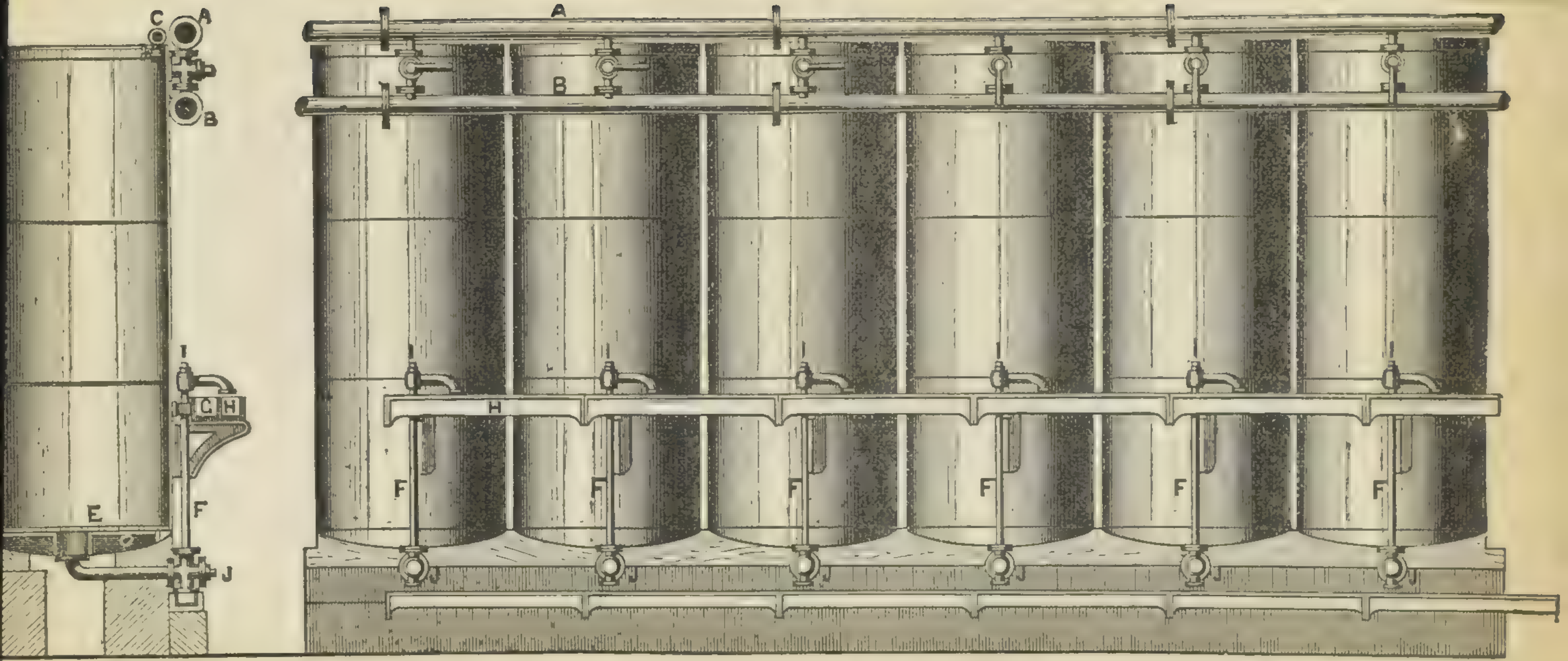
The use of charcoal in inferior quantity will indeed remove a portion of the colouring matter, and of the other impurities; but it is apt to impart to the sugar a greyness of colour and a dullness of tint, which renders its appearance unattractive, and thus unfits it to pass at once into the hands of consumers, and so reduces its value to or even below that which it might have had, had it been subjected to mechanical filtration only.

After the charcoal has been in use for some time, its grains become clogged with the impurities they have taken up, and its power ceases until these have been removed, an operation which is usually effected by thorough washing and subsequent re-calcination.

The charcoal filters employed by the planter are usually about ten feet high and four feet in diameter. They are generally open at the top. Near the bottom is a grating of iron; a piece of filter cloth is laid upon this, and then the vessel is filled in with charcoal up to about twelve inches from the top.

The cane juice or syrup to be filtered is poured into the space thus left at the top, and gradually percolates through the charcoal until it reaches the space below the grating, whence it is drawn off by means of a cock. Care must be taken in first charging the filter with liquor, that the whole of the charcoal is saturated, and all the air present is expelled before any of the liquor is drawn off, otherwise the filtration will be very irregular.

Each filter must be connected with three sets of piping, one of these will supply it with cane juice, the second with syrup concentrated up to 25° or 30° B., and the third with pure water.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When the filter has been filled with fresh charcoal, syrup will first be run into it, and it will be supplied with this until its decolorizing power is pretty nearly exhausted. The supply of syrup will then be shut off, and the filter will be used for some time to filter cane-juice fresh from the defecators. As the power of the charcoal has already been exhausted, it acts upon this simply as a mechanical filter. At the same time the syrup with which the filter was charged is driven out as the cane juice enters, and its place occupied by this latter liquid, which is much less rich in saccharine matter. After the filter has been used for some time in this way the supply of cane-juice is shut off, and pure water is run on to the filter. This, in its turn, drives the cane juice before it, and the supply of it to the filter is continued until the water running off at the bottom of the filter no longer contains sufficient saccharine matter to pay for concentration; the scarcity and dearness of fuel, &c., usually make it impracticable to extract the sugar from the charcoal as thoroughly as is usual in European refineries.

It will be obvious, that since syrup, cane juice, and water are all run over the filters, it is necessary to arrange the cock by means of which the liquor is drawn off, so that it can discharge into any of several channels, in order that these various qualities of material may be kept separate.

It will also be obvious that it is essential to have several filters at work, in order that while one is filtering syrup, a second may be filtering cane juice, and the third having pure water run over it, or emptying and refilling.

The filters are sometimes made closed at the top, and the liquor supplied to them with a "head" of several feet, the whole being so arranged that the liquor discharged from the bottom of one filter may be brought back by a syphon, and discharged on the top of any other filter, so that it passes through two filters instead of one before finally passing away. This arrangement entails a good deal of extra complication and expense, and is not generally deemed necessary for the planter, as in his case the powers of the charcoal, if not thoroughly exhausted by the syrup, are sure to be so by the cane juice.

Before coming to the description of the apparatus used in revivifying the charcoal, we must give a sketch of an arrangement of charcoal filters.

In the accompanying sketch six charcoal filters are shown, which are supplied with liquor, juice, and water by the pipes marked A, B, and C, respectively; the man-hole is marked D; the grating on which the filter cloth is spread, E; the liquor and juice are drawn through the pipe F, which discharges into the gutters G and H through to the swivel joint I. The water is discharged through the cock J in the gutter below.

The impurities with which the char becomes gradually clogged may be removed in various ways. Very many of them may be removed in great part by washing thoroughly in pure water. Water used for this purpose should not be too hard, as in that case the char takes up carbonate of lime from it, and the pores are gradually filled up, as well as other inconveniences produced; if, on the contrary, the water used be *very* soft, it may dissolve a portion of the carbonate of lime naturally present in the char; and this is objectionable; because when the proportion present falls below 2½ per cent. it is apt to be insufficient to neutralize the weak acids almost always present in sugar; and in that case the liquors become sour. This is especially likely to take place with the weaker liquors, and is often the means of introducing iron (through the action of the acids upon the filters, &c.) into the sugars made from them. The energy of water in removing both vegetable and mineral impurities is greatly increased by employing it hot, and in refineries it is by no means unusual to use boiling water for washing the char.

Many impurities may be removed by fermentation. This goes on most rapidly when warm water is poured on to the char until it covers it, and the action is still further intensified, if the water thus added already contains vegetable matter in a state of fermentation. The organic matter present is thus decomposed, and the acids formed during the process combine with some at least of the mineral impurities, such as lime, to form soluble salts. Both vegetable and mineral impurities are thus rendered easier of removal by subsequent washing with water. When the process of fermentation above described is used it is generally conducted in the filters themselves, which are thus kept out of use for a considerable time. This inconvenience may be avoided by adopting what is called the "dry" method of fermentation. This consists in piling the char in heaps on the ground, and keeping it warm and moist, but not wet. In this arrangement care must be taken not to pile up the char too high, as it is essential that air should be able to penetrate to all parts of the mass. "Dry" fermentation proceeds very much more slowly than that conducted in the filters themselves, and thus, though it sets the filters free, it keeps the char out of use for a much longer time.

Fermentation and washing are spoken off by Mr. Wray and also by Dr. Evans, in their works on sugar, as being sufficient to restore to the char the energy it has lost. They are, however, never used alone, reburning being always resorted to as an after process. Fermentation, indeed, is rarely used at all now in the manufacture of sugar from the cane, though in beet-root sugar factories it is employed, both vegetable matter and lime being much more abundant in beet than in cane juice.

Hydrochloric acid is also sometimes employed as a purifying agent. When lime is present in great excess in char it is useful in removing it, and when used in dilute solution it is also capable of taking up an excess of iron, if this should have been permitted to get into the char. This agent must be used with very great care, it should only be employed in beet sugar factories, or where the water is very hard, and the char quickly becomes clogged with lime. When in solution, it readily attacks iron and other metals, and if used in excess will also dissolve some of the phosphate of lime present in the char. It is also very difficult entirely to neutralize it, and if any traces of it are left in the char, they will injuriously affect the liquors first passed through it. These will come out brighter and more beautiful to the eye than usual, but will not boil so well.

Hydrochloric acid may be applied either in dilute solution or, as patented by Mr. Edward Beanes, in the form of gas. The latter form of application possesses some considerable advantages, but requires special apparatus for carrying it out.

Reburning is the process which is more generally trusted to than any other for the removal of those impurities which washing has failed to extract. The processes which may be included under this head are the preliminary drying of the char, the actual re-calcination of it, and the cooling which it must undergo before it can safely be exposed to the air. All these processes are conducted in the arrangement of pipe kiln, of which we give an engraving.

The drying must be effected at a moderate temperature. If too great heat be applied before the char is thoroughly dry, the water will be decomposed, and will injure the char by combining with the carbon present in it.

Air must be carefully excluded from the char while it is being reburnt and cooled down. Should it find its way in, the carbon will be partly or entirely consumed, according to the quantity of air admitted; in the latter case the char would, of course, become quite useless.

The effect of reburning is to carbonize the small quantity of organic matter not removed from the char by washing. The carbon thus formed is deposited within the pores of the char, which is thus often found to get richer in carbon as it gets older. As carbon is the active principle of char it might be thought that it would thus improve, but this is not the case. The effect of this deposit of carbon is to clog up the pores of the char, and when this action takes place to any considerable extent the effective power of the char is seriously reduced. Thorough washing is the best preservative against this evil.

Another effect of constant reburning is gradually to fuse the phosphate of lime, of which the skeleton of the char is chiefly composed, and thus to close up, or greatly diminish in size, the pores contained in it. This action is rendered manifest by the great *apparent* increase in density which takes place as char becomes old. Thus a ton of new char will occupy about 48 or 50 cubic feet; a ton of old and worn-out char will only measure some 30 to 35 cubic feet; yet the density of the constituents of the char is very nearly the same in the one case as in the other; so that the apparent increase in density is due to the closing up of the pores either by fusion or by the deposit of carbon or lime within them.

The constant handling and moving of the char during the processes of washing and reburning also causes a quantity of it to crumble away in the form of dust too fine to be used for filtering, and which, therefore, must be got rid of.

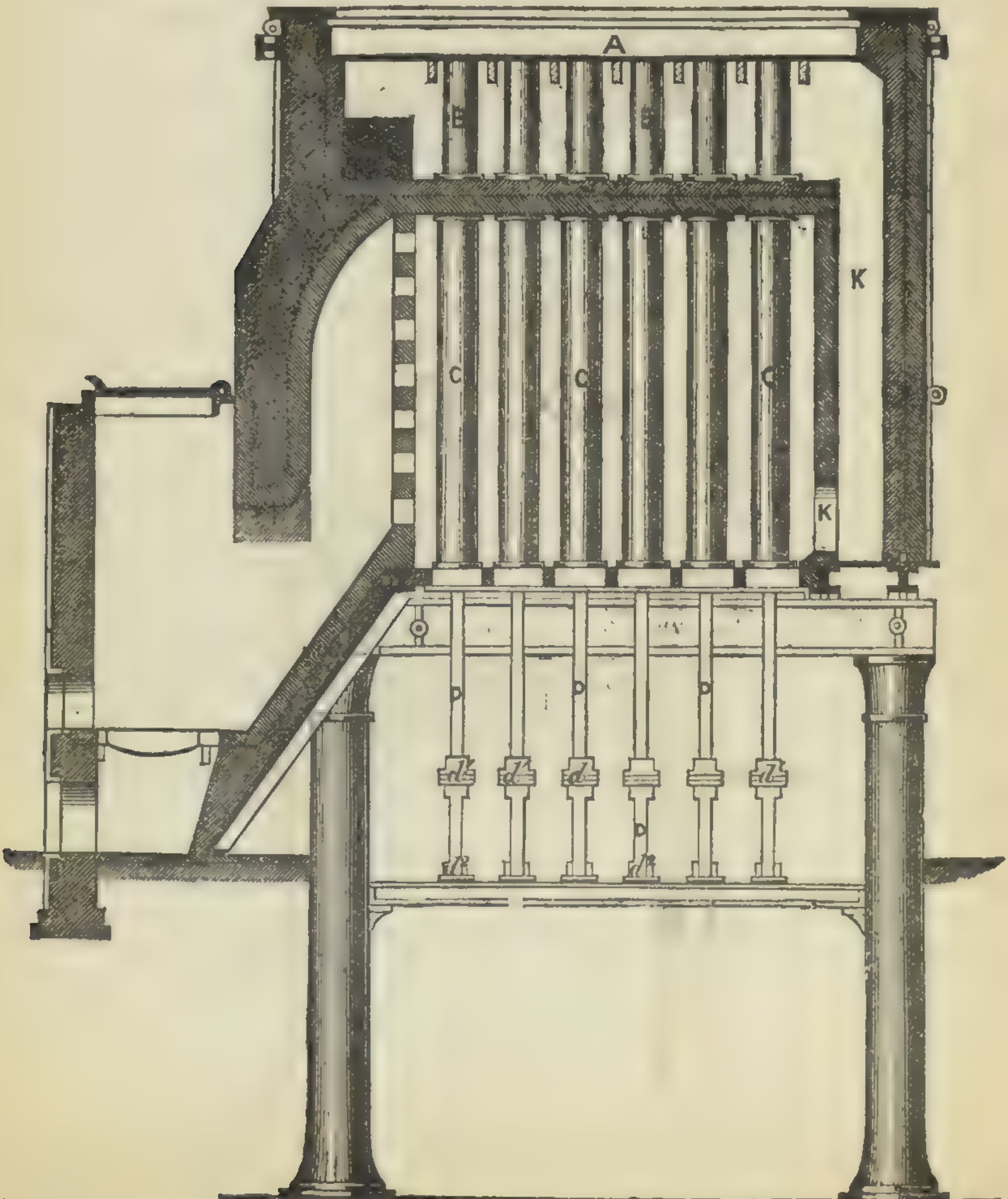
Char is thus constantly deteriorating through the action of a variety of causes. Either the carbon originally present in it may be decreasing, through the admission of air to it during the process of reburning, or its pores may be filled up with fresh carbonized matter; the carbonate of lime may be too much diminished by the use of very soft water for washing, or the pores of the char may become clogged with this material through the absorption of lime from the liquors, or the use of very hard water for washing; and the diminution of the effective power of the char through the gradual fusion of the phosphate of lime in it, and its gradual wearing down into dust, is always going on.

The stock of char accordingly requires constant renewal. In a refinery, the whole of the char employed should be renewed in the course of from two to four years, but the planter would not need to renew his stock so frequently as this, since he would not employ it so continually.

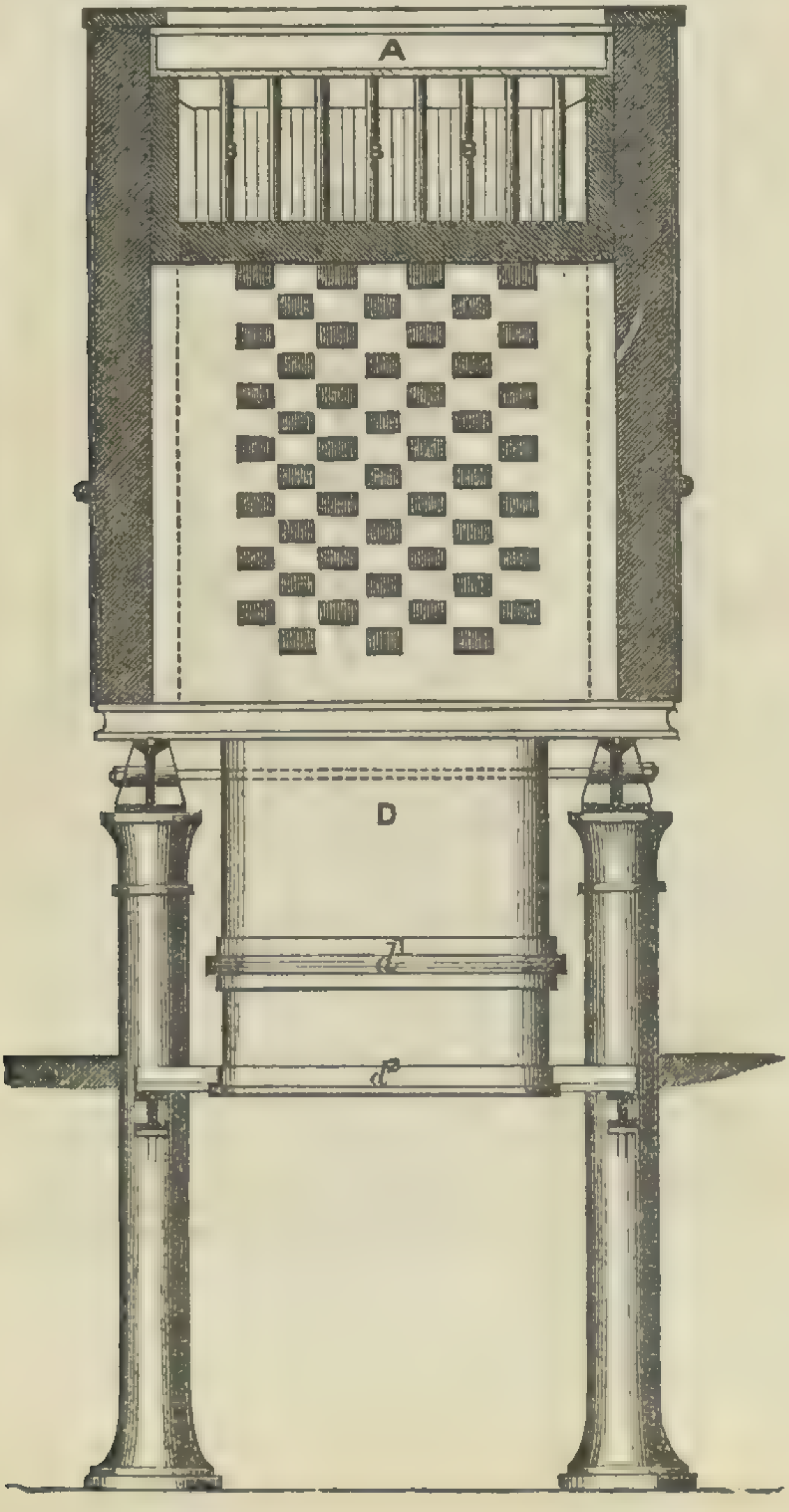
It will be observed that many of the evils mentioned above are directly dependent upon the use of reburning as a means of revivifying the char. Yet notwithstanding this, reburning is found by general experience to be the most reliable means of effecting this object.

Kilns for the reburning of char are of two distinct types; the one consists of vertical pipes, usually of oval form, through which the char gradually gravitates, being dried in the upper portion, reburnt where the heat is most intense, and cooled down in a continuation of the pipes below the furnace; the other consists of one or more revolving cylinders or retorts.

The chief objection to this latter class of kilns is, that in them the char is kept continually in motion, the grains rubbing against one another as they roll over, and the waste by attrition is consequently very great. The reburning is also not so equally effected as in the pipe kilns, the larger grains of char being almost always overburnt, while the smaller ones run the risk of not being burnt enough. In addition to these objections, most of the arrangements of revolving retort kilns are not economical in fuel. Below we give an illustration of one of the best modern arrangements of pipe kiln, as manufactured by Messrs. Manlove, Alliott and Co., of Nottingham.



In this apparatus the char to be reburnt is spread upon the plates A, where it is partially dried; it next passes through the drying pipes B into the reburning pipes C, and from them into the coolers D. It emerges from these through the valves $d^1$ and $d^2$, the quantity allowed to pass at each discharge being that contained in the coolers between the valves. The furnace is arranged outside



the kiln, and the products of combustion, after passing amongst the reburning pipes, are led by the flue K to the place in which the drying pipes are placed.

A new process of revivifying char, with which Dr. Eissfeldt's name is associated, has been introduced within the last three or four years into Germany, and more recently into France. It consists in first subjecting the char to fermentation, and then treating it successively with hydrochloric acid, steam, and ammonia water. M. Manoury, who represents the process in France, claims for it the following advantages:—

1st. It enables the reburning kilns to be abolished.
2nd. The char is better revivified by this process.
3rd. A greater saving of char is effected by its use.
4th. The cost of revivification is lessened.
5th. The apparatus need not be worked continuously; while reburning kilns must be kept always at work if economy in fuel is to be regarded.

If the claims thus set up are established in working on a large scale, the process will prove most useful; but we do not think that the advantages of the process are as yet sufficiently established to make it wise to try it in the Colonies, or anywhere away from the direct superintendence of the inventor. The system has, as yet, only been applied in beet-root factories, and might not prove equally applicable where cane juice is operated upon.—*British Trade Journal.*

A Monster Sugar-Pan.—Messrs. Adams & Co., the well known sugar pan makers, have just completed the building of a monster vacuum sugar pan for the Counterslip Sugar Refinery, Bristol. The pan is said to be the largest ever made, and its dimensions are 12½ feet diameter, and 13 feet deep, with heating powers of nine large steam worms, of an aggregate length of 700 feet. The pan will be capable of boiling about 27 tons of sugar at a single charge, in the space of about three or three and a half hours.

# ON SOIL ANALYSES AND THEIR UTILITY.*

BY EUG. W. HILGARD,

*State Geologist of Mississippi.*

In the *American Journal of Science*, for September, 1861, Prof. S. W. Johnson published a criticism on the "Soil Analyses of the Geological Surveys of Kentucky and Arkansas," whose strictures, to a great extent eminently just, appear to have so impressed the scientific public in this country, that few, if any, soil analyses have since then been made in connection with any state or national survey, excepting that of the State of Mississippi, where the work already begun was continued, either by myself, or under my charge, or recommendation, by others. Holding myself responsible for this departure from the generally adopted views, I propose in the present paper to discuss specially Prof. Johnson's objections, and to give my reasons for persisting in a course of research that has, more than once, secured true sympathy. While I consider the work far from being as complete as it should be, and for that as well as for other reasons its publication in detail may be delayed for some time, yet I think what can now be said is of sufficient importance to be brought before this meeting.

I propose, in this discussion, to maintain the mainly practical standpoint assumed by Prof. Johnson himself. I shall therefore leave out of consideration the performance of such exhaustive investigations of *all* the physical and chemical properties of the soil, as have been made in some cases, for special purposes, *e.g.*, by Prof. Mallet, on some of the cotton soils of Alabama. If the investigation of each soil, to possess practical importance, requires from three to six months labour, we may as well, for practical purposes, consider such researches out of the question for the present. We want something analogous to the metallurgical assay of minerals, as distinguished from their complete ultimate analysis. So far, therefore, as the agricultural qualities of a soil may be inferred and approximately estimated by an experienced eye, I would relieve the chemist from the exact numerical determination, *e.g.*, of the power of absorbing heat from the sun, the specific heat, the "water-holding" power, the capillary co-efficients, &c. However necessary for theoretical investigations, I hold that, for practical purposes, these laborious determinations may in most cases be dispensed with; since from what has already been done, or what can be done with a few typical soils, we may infer the comparative magnitude of these coefficients with a sufficient degree of approximation.

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* Read at the Dubuque Meeting of the Am. Assoc. Adv. Scic., August, 1872.

The amount of labour bestowed on each soil by Dr. Peter, as reported in the Kentucky and Arkansas surveys, approaches very closely the limit beyond which the *immediate* advantages to be derived from such knowledge of soils as analysis may impart, would seem, to many, disproportioned to the expenditure involved. How very modest we are, truly, when a purely scientific object is involved, whose immediate practical application is not obvious at a glance! In what other branch of technical science would it be thought admissible to proceed without obtaining such knowledge of the prime materials as chemistry may afford, even if no immediate application of this knowledge be foreseen? Our public treasuries are constantly drawn upon for hundreds of thousands of dollars, in behalf of objects of at least questionable usefulness. Yet Prof. Johnson seems to have thoroughly satisfied our State geologists that they are not justified in giving the virgin soils of their respective states the benefit of such light as chemistry may even now confessedly afford; apart from the important general inferences which may be fairly expected to be drawn hereafter from the history of their cultivation. How are we to advance in our knowledge of soils if we abandon as hopeless the determination of their chemical character? Are the proofs that have been brought against the utility of soil analyses really of such a character as to justify so grave an omission? an omission, too, which in many cases cannot hereafter be supplied. Even in the comparatively youthful State of Mississippi, I have found difficulty in obtaining reliable specimens of some soils, whose great productiveness had led to their cultivation by the earliest settlers, over the entire area of their occurrence.

I question the propriety of this omission, and the justice of the *testimonium paupertatis* thus inflicted upon agricultural and analytical chemistry.

To define my position I premise that —

1. I fully agree with Prof. Johnson as to the comparative uselessness of a single analysis giving the percentages of soil ingredients found, in ordinary cases. It is only when such analysis demonstrates the great abundance, or very great deficiency, of one or several primarily important ingredients, that, by itself, it conveys information of considerable practical importance. Note that such cases are not altogether infrequent even in virgin soils.

2. I agree that an "average soil" is *a non ens*, except as referred, comparatively, to a particular set of soils closely related in their origin.

3. Also, that the claim of being able to detect the minute differences caused by cropping without return to the soil, is precarious, and perhaps beyond the power of our present analytical resources.

4. I further admit that, ordinarily, the analysis of soils long cultivated, and treated with manures, can give but little and very partial information as to the condition and composition of the soil; from the great difficulty, if not impossibility, of obtaining fair representative specimens.

5. Furthermore, that to designate soils by the names of the Cretaceous, Carboniferous, or Silurian strata they may happen to overlie, is very loose practice; since in most cases they are derived from Quaternary deposits, which may or may not have been influenced in their composition by the subjacent rocks.

On the contrary, I demur, in the first place, to the broad assertion that "it is practically impossible to obtain average specimens of the soil," as inapplicable to a very large class, especially of virgin soils, covering large areas with a uniformity of character corresponding to that of subjacent formations, from which they have been directly derived, by substantially identical and uniform, or uniformly variable processes.

The importance of this exception is not, it is true, very obvious in the stony fields of New England (such as discouraged Professor Johnson in his vacation trip to Northern New York), or in fact, in any district where a great variety of formations has directly contributed toward forming the soil, and "chunks" of undecomposed minerals are diffused through it. In such cases, the analysis of the rock which has predominantly contributed to the mass of the soil proper, would be a more correct index of the prevalent characteristics of the latter than if itself were taken in hand. And from such analyses we could at least deduce what ingredients, and in what form, it would certainly be useless to add to the soil.

But when we come to the great plains of the West and South-West, whose soils are consistently derived from wide-spread quaternary deposits, composed of materials almost impalpable, save as regards siliceous sand, or even the rolling uplands of the Gulf States, whose subsoil stratum of "yellow loam" can only be diluted, but not otherwise changed by the admixture of the underlying drift, leached long ago of everything soluble in carbonated water or available to plants: the objection based upon the supposed impossibility of securing representative specimens, becomes obviously untenable, as I shall hereafter show, from the close correspondence in the composition of soils, and especially *sub*-soils, from widely distant portions of the State, derived from the same geological (quaternary) stratum.

A word in regard to the "freaks and accidents" mentioned by Prof. Johnson as liable to make sport of the devoted analyst. Undoubtedly such errors must be ultimately provided against by multiplications of analyses (not necessarily of the same acre, but of other corresponding specimens, in the sense mentioned above); and while questioning the efficiency of a bird or squirrel in vitiating a properly taken sample of soil, I must admit the disastrous consequences which might result if a dog, cow, or horse were similarly concerned. No specimen of "virgin soil" can, of course, be obtained where such animals usually do congregate. But, as a rule, it is not all difficult to avoid such places; while the chance of accidentally hitting upon a sporadic animal deposit in the broad woods or prairies is singularly small, and is notably diminished by the circumstance, that an attentive observer (and none other should take soil specimens) will be able to distinguish such localities for years, by the peculiarity of their vegetation. I will remark, however, that I consider the sampling of a soil with a view to securing a representive specimen, as a matter second in difficulty and delicacy only to the analysis itself; that I rarely have thought it worth while to analyse specimens sent by other than intelligent persons specially instructed by me; and even then have frequently had to reject them, from their having obviously been taken at an improper locality, *e.g.*, near a footpath, by the side of a fence, on a partially denuded hillside or ravine, in the bed of a run, at the foot of a tree, &c.

The question of *depth* must, in my view, be left to be determined by the circumstances of each case, except in so far as the extreme depth to which tillage may cause the roots of crops to reach, must be within the limits of the samples taken. Of these, *one* should ordinarily represent what, under the usual practice of tillage becomes the arable soil; another the subsoil not usually broken into; a third will in most cases be useful to show what materials would be reached were the land to be under-drained. As a rule, I have taken no specimens of soil to a less depth than six inches, and as much deeper as uniformity of colour reached—for obvious reasons. But in special cases, when important differences were suggested by the aspect of the soil and subsoil, they have been separately examined, at whatever depth the change of colour might occur.

With soils of the character referred to, samples selected and taken with due care, and strict attention to thorough intermixture, both in the field and subsequently in the laboratory, I am unable to see why even two grammes may not correctly represent the characteristics of a 1000 acre tract. Not that every point of that tract would be likely to give the same percentage result, perhaps, especially as regards the surface soil, which might in places be more clayey or more sandy than the sample analysed. Still, the relative proportions of the soil ingredients, and their degree of availability, would remain substantially the same; the wider range and readier penetration of roots in sandier soils, making up, within certain limits, for the smaller percentage of available ingredients in a given bulk, as compared with more clayey ones.

From the fact that the atmospheric surface water must, in its course, inevitably have a tendency to bring about such inequalities, by carrying forward the finer particles of the soil in larger proportion than the coarser ones, as well as from the greater influence of vegetation, we shall, in a series of analyses, made a postulate by Prof. Johnson, expect to find a closer agreement between those of subsoils than those of surface soils. Such I find to be very decidedly the case; so much so that I habitually look to the former as the most reliable index of a soil's distinctive character. To this there can be no legitimate objection, when, as in all the upland soils now under consideration, the surface soil is directly derived from the subsoil, and its depth is less than thorough culture would give to the arable soil.

As regards the analysis itself, I premise that I have always found even the most "chemically pure" reagents sold by dealers quite inapplicable to the purpose of soil analysis. From first to last, I have prepared or purified these myself; and, as regards the acids, especially hydro-chloric, I have found it necessary to reject, as a rule, even the purest, after keeping it for a few weeks in a glass bottle. The same is true, and perhaps in an aggravated degree, of aqua ammoniæ. The severe ordeal of slow evaporation on a bright platinum foil will rarely be passed by ammonia a fortnight old; and still less frequently by hydrosulphide of ammonium.

Armed with these, and a multitude of other precautions, usual and unusual, to secure the utmost possible accuracy; always treating the soil with the same large excess of acid of uniform strength, and precipitating all corresponding precipitates as much as possible from the same volume of liquid; using none but the best Bohemian glass and platinum vessels, and filters specially extracted—operating, in short, as uniformly as the nature of the materials would permit: I confess I felt considerable confidence in the correctness of my results, until the experiments made in Bunsen's laboratory, on the solubility of glass vessels, gave rise to unpleasant doubts. On consideration, however, I found that the (sensibly constant) error so introduced would not, when allowed for, amount to more than the differences between two analyses of one and the same material, or vitiate in any serious degree the conclusions arrived at. Nevertheless, I shall hereafter, to the utmost possible extent, carry on all operations liable to introduce errors on this score, in platinum and porcelain vessels, as advised by Bunsen.

As regards Dr. Peter's failure to determine the amounts of soluble silex, nitric acid, ammonia, chlorine, and the degree of oxidation of the iron, I agree that the former is desirable, not only because, whether "essential" or not, some plants do habitually absorb it in very large quantities, and it might be best to let them have it; but also because it is a desirable index of the degree of decomposition which the soil silicates have undergone. I have therefore made this determination regularly, by boiling with solution of sodium carbonate. In a series of these determinations, an unmistakable relation between the soluble silex and the amount of lime in the soil becomes manifest; as might, indeed, have been foreseen.

As regards nitric acid, the consideration suggested by Prof. Johnson himself, viz., that its quantity must be exceedingly variable, within short periods, in one and the same soil, seems to me a sufficient dispensation from the laborious determination.

The same holds good, in a measure, for ammonia. Its quantity varies continually in the soil, as it does in the atmosphere; its chief absorbers in the soil are "humus" and clay. Where these prevail largely, ammonia can scarcely be deficient as a nutritive ingredient to an injurious extent; albeit, more might doubtless be beneficially added. Moreover, the characteristic effects of ammonia on vegetation are sufficiently obvious (in "running to weed") to render its determination in virgin soils, laborious and even uncertain as it is, a matter of comparatively little practical consequence, however great might be its theoretical interest.

As for the determination of the degree of oxidation of iron, I confess I fail to see its practical bearing. When ferric oxide is present, plants surely can have no difficulty in reducing the modicum they need to a soluble condition. When ferrous oxide exists to any great extent, it indicates a want of drainage, and manifests itself both in the colour of the soil and in the poisonous effect on vegetation. But farmers surely do not need the aid of chemical analysis to tell them that their soil needs drainage and aëration! A determination made to day would be of no value to-morrow, if the soil had been ploughed in the interval.

Finally, Dr. Peter *does* determine *chlorine* in the treatment of soils with carbonated water, though it is not put down in the general analysis. However, the soluble chlorides, like the nitrates, are so constantly liable to variation, and as experience shows, so little likely to be deficient in the soil, that its omission would not be a serious practical objection.

*(To be continued.)*

## ON THE INFLUENCE OF FORESTS ON RAINFALL.

By Alfred Fryer.

(Continued from page 35, vol. v.)

The newspapers published in the island of Mauritius have from time to time printed letters which have contained valuable information on the influence which forests exert upon the climate of tropical lands.

The following is taken from the *Commercial Gazette*:—

"We have been favoured with the letter we publish below, by Mr. *P. E. de Chazal*, the gentleman to whom it was addressed, and we cannot do better than introduce it with the judicious observations contained in his private note to us:—

"I think the practical suggestions the letter contains on the replanting and rewooding our forest land are of great interest. *Mr. Duncan* has had a long experience of our climate, and the list he annexes of useful and fast growing trees will, I am sure, prove an interesting document to be added to the '*dossier*' that must have been made for the working of the new ordinance at present before the Council."

"The following is the letter of *Mr. Duncan* :—

"Dear Sir,

"Having noticed in the *Overland Commercial Gazette*, which I received from the Mauritius by the last mail, some correspondence on the subject of replanting the hills and waste lands of the island; and taking a warm interest in any undertaking which will benefit the colony, I venture to inform you of what took place on the subject in question some years ago, when I was Director of the Botanical Gardens. I have taken the liberty of addressing these observations to you, knowing that you are a great advocate for preserving the water sources and woods of your beautiful island. And should you be of opinion that any of the observations which I now make may be useful in furthering the object in view, you are at liberty to make whatever use you may deem proper of them."

"1. As near as I can now recollect the correspondence above alluded to took place between the *Hon. L. Arnaud*, (who was at that time a member of the Legislative Council) and myself, and although I mentioned the subject to many other influential gentlemen, *Mr. Arnaud* was the principal one who entered fully into my views and saw the necessity, at that remote time, of carrying out such an important work. I remember him asking me to draw up a system suitable for carrying out the undertaking, in order that he might submit it for the consideration of other influential and interested persons, which I did."

"2. The system which I proposed to him then, was (as far as I can recollect), as follows :—

"1stly. The island to be divided into sections or stations."

"2ndly. A practical man, who thoroughly understood the planting and management of forest trees, to be stationed at each section or station, and to be assisted by as many labourers as might be deemed necessary."

"3rdly. These practical men and labourers to be under the supervision and control of the Director of the Botanical Gardens, who would make occasional visits to each station, and see that the work was properly carried on, and who would order the labourers to be shifted from station to station, as circumstances might require."

"4thly.—A small plot of ground near each practical man's cottage to be set apart as a nursery for the rearing of such trees as might be required for the station, and which could not conveniently be obtained from the Botanical Gardens."

"3. The system which I recommended for planting was as follows :—

"1stly. All small seeding trees, such as the Filao, which would receive injury from drought and the heat of the sun, should be sown in boxes, and afterwards transplanted into bamboo pots, in which they could remain until they were a foot high, when they might be permanently planted out. The planting out should be done during wet weather."

"2ndly. All large seeding trees, such as the Badamier, to be treated as follows: Holes should be dug out with a 'pioche' about three or four feet apart, the soil should be loosened to at least a foot deep; when all are dug, a labourer to be sent with a basket of seeds with directions to put one or two into each hole and cover them over with soil, leaving the soil where the seed was placed lower than the surrounding soil, to collect moisture. The object of digging the holes is to loosen the soil, (which on the hill sides is generally very hard and stony) so as to allow the seed, when once started to make more rapid progress. I have known trees which have been planted without these holes to remain for years without making any growth; whilst on the other hand, I have known trees planted in holes prepared as above described, to become large in the course of a few years. And the larger the holes the more rapid will be the growth of the trees; as a proof of what I have stated, should you be going to Pamplemousses you would notice a clump of Filao trees growing on a barren bank, near the entrance to the Director's residence, on a piece of ground between a small stream and the road leading to the Canton de l'Eglise. This clump of trees was planted by me, in the manner above described, just before I left the colony, and I am informed that they have already become trees. This alone is a proof that had my system met with the support which a matter of such vital importance to the community at large ought to have received, Mauritius might by this time have had its hills and waste lands covered with beautiful and useful timber, rendering the island productive and healthy, by attracting rain and retaining the moisture by their shade."

"4. With regard to planting the sea coast, I proposed that the Pas Géométriques and other waste lands near the sea should be planted with Cocoanut trees. I need not add, that no more useful or more graceful trees could possibly be planted there, and they thrive as well on the sand as elsewhere."

"5. In planting the sides of the water courses I would suggest that Bamboo be largely used, as it does well in damp situations. It is a useful timber for many purposes, and the shade which it would give by overhanging the streams would be of immense value in preventing evaporation."

"6. I beg particularly to call your attention to the Badamier, the timber of which when old is equal, if not better, than any Singapore wood which is introduced into the colony. I consider it one of the finest trees which can possibly be planted, and which will ultimately prove to be the most useful. The timber is easily worked, and being a tree of rapid growth, it cannot be too largely planted—seeds of it can be obtained in any quantity in the colony. I would also draw your attention to the Filao, which is likewise an excellent timber for many purposes, and is a very rapidly growing tree."

"7. As seeds soon dry up and lose their vitality, owing to the heat of the climate, it is important that they should be sown as soon as possible after they are gathered, so as to ensure success."

"The establishment above mentioned would only be required whilst the planting process was being carried out; once done it would only be necessary to retain a staff sufficient to protect the trees from depredations, &c."

"9. I annex hereto a short list of trees which I consider would answer well, and which it is quite possible might be supplied in a great measure from the Botanical Gardens, either in plants or seeds."

"10. Seeds of indigenous forest trees might also be planted largely at the time other trees or seeds were being put in."

## LIST OF TREES.

| BOTANICAL NAMES. | LOCAL NAMES. |
|---|---|
| Acacia of sorts.................. | Black wood and others. |
| Adansonia ...................... | Baobab. |
| Areca of sorts ................... | Cabbage-Palm and others. |
| Artocarpus Integrifolia .......... | Bread-Fruit Tree |
| Bambusa of sorts ............... | Bamboo. |
| Barringtonia ..................... | Gatheridge-tree. |
| Bassia ......................... | Illipe. |
| Bauhinia of sorts ............... | |
| Casuarina ...................... | Filao. |
| Cathartocarpus .................. | Cassia of sorts. |
| Celtis of sorts ...... .......... | Nettle-tree. |
| Citrus of sorts ................. | Shaddock, &c. |
| Colvillea Racemosa ............. | |
| Cordia of all kinds ............. | |
| Crescentia ...................... | Calabash-tree. |
| Dalbergia of sorts .............. | |
| Dillenia of sorts ................ | |
| Elœocarpus serratus.............. | |
| Elœodendron..................... | Olive-wood. |
| Erythrina of sorts ............. | Coral-tree. |
| Eugenia of sorts ................ | Roussaillier and others. |
| Ficus Nitida .................... | Arbre de l'Intendance. |
| Flacourtia of sorts ............. | Plum-tree of Madagascar. |
| Garcinia of sorts ............... | Mangostana. |
| Guazuma ....................... | Orme Pyramidale. |

| BOTANICAL NAMES. | LOCAL NAMES. |
|---|---|
| Hymenœa | Locust-tree. |
| Imbricaria of sorts | Bois de Natte. |
| Jambosa of sorts | Rose-apple. |
| Kiggelaria Jimuata | Chandallier. |
| Lagerstrœmia of sorts | Guava. |
| Lecythis Minor | Smaller Cannon-ball-tree. |
| Mangifera | Manguier. |
| Michelia Tsiampaca | Champaca. |
| Mimusops | |
| Nepheleum Litchi | Letchi. |
| do. Longan. | Longanier. |
| Nuxia Verticillata. | |
| Pandanus Utilis. | Vacoua. |
| Parkinsonia Aculeata | Jerusalem Thorn. |
| Poinciana Regia. | Flower-fence. |
| Rapolocarpus Lucidus | |
| Sapindus of sorts | Soap-berry-tree. |
| Spondia Dulcis | Fruit de Cythère. |
| Tamarindus | Tamarind. |
| Termanalia of sorts | Badamier. |

The following letter, bearing the signature "W.," is taken from the same newspaper :—

"Dear Sir.

"In your Overland paper of 12th January last, I have read with interest the following remarks on the year 1871, as to the fortunes of Mauritius during that period. You say 'two important measures were before the Legislative Council at the beginning of 1871, which we regret to say have made little progress during the year. Sanitary laws and laws for the preservation of forests and rivers not having been amended.' In looking back to your December Overland paper, I find these words: 'much disappointment is felt at the slow progress made in the examination of the Woods and Forests Ordinance, and its postponement is greatly regretted.' 'It is pointed out that the passing of the law relative to the planting and replanting of the eligible waste lands of the Island is of immense importance to agriculture and public health.' 'While the Woods and Forests Ordinance is pending, the destruction of timber is being carried on with extraordinary activity."

"On the first page of your January Overland paper, already alluded to, I find you still complain that the enactment is not hastened, seeing that the evil it is intended to remedy augments each day, and the destruction of woods and forests progressing with abnormal rapidity. I, however, derive this satisfaction from your complaints; that at last the question of Woods and Forests in Mauritius is really beginning to be looked upon as 'important.' If my humble endeavours, through the columns of your valuable paper, have tended to attract attention to this great question of the future prosperity of Mauritius, I shall consider myself well repaid, and grateful to you. So at last there are to be Forest Laws in Mauritius! (that is to say when they are completed, the speed applied to them hitherto not being express). I am well aware the question is one of great difficulty to legislate upon, still, why allow less important questions to take precedence of this one, on which hinges so much the future prosperity of the colony? and which is still left open to the axe of the destroyer, who you say is very busy in removing that which it will take expense and years to replace."

"Mauritians have a neighbour, who has proved himself a shrewd fellow, and wide awake to his taxes, and the means from whence they were derived. I allude to the Sayyid of Zanibar. He found that the average rainfall during the year was formerly from 100 to 130 days, but that of later years rain had diminished: the result of felling and disforesting the land for clove plantations. In fact, the country was almost denuded of the cocoa to make room for cloves. The Sayyid became alarmed at the decrease of rain, and threatened confiscation to those who did not plant in proportion of one to three. He instituted extensive nurseries in the Màshàmbà. And as this palm bears after six or seven years, it soon recovered its normal status. In glancing into an old number of the *United Service Magazine* of 1842, under the heading of "West Indies," I found these words:—'Dominica. The great abundance of trees must be the chief reason why the Island is visited with heavy rains.' This is the broad contrast to many of its sister isles, Antigua, for instance, where little rain falls."

"And surely Mauritians must be convinced on visiting Bourbon, what wholesale denudation of the mountains has done there. A letter I lately received from a friend, describes the country as parched up, sugar estates abandoned, and poverty supreme, owing to the failure of rain."

"I have no doubt large quantities of rain have fallen in Mauritius during the last few years, perhaps not much less than in former times. But these rains have no longer been the continuous, genial, fertilizing, protracted tropical rains. But rains at uncertain and unseasonable times, torrents accompanied by floods, and succeeded by long periods of ruinous droughts—in fact, the intermediate stage between fertility and sterility, and displaying exactly the symptoms observed in all countries, subject to a gradual denudation of its forests. Hence climate changes and uncertainty of seasons—facts verified in Mauritius even as late as 1871, when a season of great promise gave deep disappointment."

*Dr. Cleghorn, M.D., F.L.S.*, Conservator of Forests, Madras Presidency, says:—'It is the opinion of many persons, in which I concur, that the vast clearings which have taken place, have had a share in producing the irregularity of the monsoon which has of late years been so complained of in Coimbatore. The higher sholas clothing the ghauts on both sides are of the utmost importance, and the climate is believed to suffer the greatest detriment from their removal.'"

"The influence of trees on climate is very considerable, tending, as they do, to prevent the too rapid withdrawal of moisture from the soil; a point of great importance in a country where the heat of the sun is intense, and the supply of water is dependent only upon periodical falls of rain!"

"By the January mail, I sent you an interesting paper on the Forests of India. With your leave I shall quote further from *Dr. Cleghorn's* work, as the paragraphs I cite appear of much interest to Mauritians. 'The matter of complaint was, that throughout India large and valuable forests were exposed to the rapacity of the native population, who cut and cleared without reference to ultimate results, and without control from authority.' He says it is only of late years that attention has been drawn to the importance of conserving tropical forests. The result of indiscriminate denudation became apparent and rendered it imperative to organize a forest administration, to economize public property for public good. Undersized green timber was felled, and there was no renewal of trees."

"The publication of such works as those of *Meaume* and *Du Breuil* in France and of *Hartig* in Germany shew the great importance that has been attached to the Forestry in these countries where the population depends on wood for fuel. If conservation be necessary and needful in temperate climates, how imperative is it in the tropics, where the supplies of water and food are in a great measure dependent on the existence of forests."

A succeeding letter from "W." also appeared in the *Commercial Gazette*:—

"Having in my last letter used largely from *Dr. Cleghorn's* work on the Forests of South India; I offer you a few more notes, which I think must be of interest to many of your readers."

"On Conservancy of Forests, he suggests that the high wooded mountain tops overhanging the low country should be preserved with rigid care, and the forests there should not be given over to the axe, lest the supply of water may be injured. In order that the course of rivulets be overshadowed with trees, he conceives that the hills should be left clothed. The increasing wants of the hill stations have drawn attention to the necessity of conserving the remaining woods on the hills. Of the Government Rule No. 1, he says, the woods of the stations to be reserved not only for their beauty, but also for the fear of injuring the water springs. Trees to be planted in the vacant places. Rule 3 says, the cleared plots to be replanted by the Conservancy Department of Government. He calls attention to the wanton sacrifice of forests in Malabar, and records his decided opinion that unless Government takes steps to check wanton destruction, in a very few years the chief portion of these magnificent forests will present a barren waste instead of the forest trees which can adorn and fertilize the district. The conservation of these is necessary to preserve the water springs, for shelter, &c. He adds, so long as persons cut *ad libitum* in the Government Forests, without payment, the most powerful incentive to private planting is lost. Experience has shown the impossibility of preserving a forest if wood cutters and cattle are allowed enter it. All that is required is conservancy, so as to prevent tracts being cleared and to arrange for the renewal of trees being cut down. The whole of the woods near stations to be reserved, not only for their beauty, but also from the fear of injury to the water springs, their limits to be marked, trees to be planted in vacant spaces where required. No private felling of any kind to be allowed in woods or on lands belonging to Government."

"On the question of planting and replanting I find these remarks,

"The masses of people have until lately been ignorant of the value of trees, but in the vicinity of large towns and along railways they are now alive to the importance of this kind of property. Much has been done in some districts in the way of planting avenues, and the trunk roads are better sheltered by trees than formerly. Avenue trees are of immense consequence to the trunk roads of the country, and in some districts they are nearly as essential to the convenience of travellers as a smooth surface. It has been proved that carts travel further than on an exposed tract. In Mysore the system has been to reduce rents to parties planting avenues. Much has been written on the subject of planting the hills. It is scarcely necessary to dwell upon the advantages to be derived from this measure; but they may be briefly stated."

"1st. Plantations create and improve the soil and secure the permanency of the water springs."

"2nd. Plantations shelter from the winds and modify the climate."

"3rd. They furnish material for building, &c."

"4th. They furnish fuel, &c."

"5th. They are ornamental."

"Private individuals are planting largely near their dwellings, through the instrumentality of the well furnished arboretum existing in the Government Gardens. 100,000 seedlings have been prepared in baskets, in anticipation of the next rains. Trees intended for transplantation are placed in wicker baskets, through the sides of which roots readily penetrate; the half-decayed baskets are potted in the holes which have been prepared—this answers well.

Mr. F. states he planted about 8,000 Australian trees (Acacia and Eucalyptus) at a cost of 400 rupees, and has resown part of the denuded forests."

"The Government attaches the greatest importance to the preservation of trees on the hills, and readily sanctioned the sum of 1,350 rupees requested by *Dr. Cleghorn* for the planting of 10,000 trees near Utakamand, under the conviction that the outlay is trifling compared with the advantage to be derived from the plantations, an enterprise which, while it will be generally beneficial, will also be individually remunerative. The reservation of jungles is a very important subject, and now engaging attention."

"Fire-wood. As population increases and cultivation extends the subject of maintaining the supply of fire-wood becomes more important. In more advanced countries it is recognised as one of the modes of employing capital for profit. The subject has engaged attention for a long time, and private planting is greatly on the increase. The great object in the meanwhile is to prevent the Government woods from being destroyed. The providing of fuel is a matter which cannot be left till the urgent demand arises, but should be anticipated by every possible means."

"Such are a few of the measures adopted by the Government of Southern India to renew and protect their forests, which in the short period of ten years have led to the highly remunerative results, I exposed in my letter to you of 17th January last, viz., a profit of £122,000 per annum, and which is daily on the increase, and in a few years will produce a high revenue."

"At the Madras Exhibition of 1855, class IV., section VI., 'Timber and Ornamental Woods,' *Lieut.-Colonel G. Balfour, C.B.*, chairman; the following remark was recorded :—'The importance of this section of the Exhibition can scarcely be over-rated in a country like this, for it must be remembered that the value of the wood and timber here is not to be measured by the estimation in which they are held in temperate climates; here they are not only applied to those economic uses with which we are all familiar, but they also furnish fuel to all classes, and supply the place of mineral coal."

"With a short description of a tree which, I think, is unknown to Mauritians, and which thrives in Hindustan, and therefore doubtless would succeed in the Mauritius, I shall conclude my letter."

"The Sàl tree of Hindustan extends along the belt of forest along the Terai from the Ganges at Hurdwar to Brahma-putra. It belongs to the genus Vatica of Linnaeus, and is indigenous to the mountainous parts of Vizapatam and Ganjam. It may be well to notice the singular aptitude of the seed of this tree for speedy germination in connection with prospective measures of conservancy. The seed has the utmost susceptibility of germination. The Sàl seed ripens at the commencement of the rains and after the first showers, falls actually sprouting from the tree. Young plants come up in the utmost profusion and very often so thick as to choke each other, they form patches which are literally impenetrable; in this manner the forests are maintained wherever a tree remains standing to perpetuate the stock. The Sal is the most useful as well as the most abundant tree in these forests, which are therefore called Sal forests. The tree grows remarkably well, tall and straight. In open places it yields a thick trunk, throws out branches, and becomes umbrageous. Young and old are cut down, from the five years old to the full grown tree, and this has been proceeding for a lengthened period without any conservancy rules. Thousands of young trees are removed for posts, *et cetra.* With this heavy drain on the forests, young plants spring up in the greatest profusion. The woodsman removes the promising poles, and provided that a few trees remain as standards to perpetuate the stock, so remarkable is the germinating power of the seed, there is no fear of exterminating the forests. I measured straight stump shoots two years' growth, and found them twelve feet high and eight inches in diameter."

" It seems to me, if this tree has not already been introduced in Mauritius that it would be worth while to obtain, through the Director of the Government Botanical Gardens, a few of these plants and some seeds, with full information as to the habits of the Sal Tree; and then try them either at Pamplemousses or at the New Gardens at Curepipe."

*(To be continued.)*

# ANALYSIS OF SACCHARINE SUBSTANCES.

## THEORY OF THE SACCHAROMETERS OF SOLEIL & VENTZKE.

### PRECAUTIONS NECESSARY TO BE OBSERVED TO ENSURE EXACT RESULTS.

BY L. CHEVRON,

*Professor at the National Agricultural Institute, Belgium.**

[From the *Sucrerie Belge.*]

It is always necessary to determine rapidly the richness of saccharine solutions which may contain foreign matters, especially mineral salts. To estimate the purity of sugar, or the quantity of sugar contained in manufactured products, very different processes are used; some optical, others chemical.

In the chemical method, discovered by Frommherz, the proportions are obtained by means of a standard liquor. The optical method was discovered by Biot, who showed that the richness of a saccharine solution could be determined by rotary polarisation. The latter method is more exact than the former, in which several causes of error have been observed. The optical method consists in measuring by the polariscope the deviation of the rays of light which saccharine liquor produces upon the plane of polarisation. In fact, cane or beet-root sugar always affects this plane to a certain number of degrees, proportional to the saccharine molecules, which the polarised light meets with in its passage.

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* Mayolez, Editor, Rue de l'Imperatrice, Bruxelles Price 2 francs.

Various instruments have been invented for optical saccharimetry, the manipulation of which is simple enough, but the theory, based on the polarisation of light, is more complex. In the present day, it is of the highest importance for all, in any way engaged in sugar manufacture, not only to be familiar with the working of these instruments, but to be fully acquainted with their mode of action.

*Savants* who have discovered and studied the phenomena of polarisation have recorded the results at which they have arrived, either in voluminous treatises or in periodical publications; and those who wish to examine the subject thoroughly are obliged to make laborious researches. Mr. Chevron's work, named at the head of this article, will henceforth spare them the trouble. It may be said that he has supplied a great want, and that the appearance of his work will be welcomed in the sugar manufacture.

With the assistance of Mr. Chevron's volume, anyone with some knowledge of physics can now quickly acquire facility in handling the polariscope, and obtain a thorough knowledge of its principles.

The author devotes the first pages of his work to a brief glance at the principal laws of optics as applied to saccharimetry; simple and double refraction, dispersion and direction of luminous rays through biconcave, biconvex, and achromatic lenses.

After the explanation of the optical phenomena on which the use of the saccharometer is founded, the author then treats of polarisation. He explains, in a concise and methodic manner, in what this phenomena consists, and the method in which it is utilised in the analysis of saccharine matter.

Then follows a detailed description of the polariscope in general use. Another chapter treats of the mode of operation, and Mr.

Chevron concludes by elucidating a very important point—the precautions necessary to be attended to in order to ensure exact observations, and he shows how to correct the causes of error which may occur in the process.

The text is illustrated with numerous well-executed engravings, and containing two plates representing the saccharometers of Soleil and of Ventzke.

It is to be regretted that the author, in the first part of his work, has not entered more into detail, so as to make it more intelligible to the general reader. The principles of polarisation do not exactly form one of the more elementary chapters in physics, and it seems to us that many readers would have been glad to have met here with some definitions, without being obliged to have recourse to their treatises on physics.

## CROPS IN BARBADOS.

The year closes with better prospects than we expected three months since. A good November did a great deal to restore the crops wherever they were not hopelessly gone. December has not been equally good. It was showery at the commencement, and during the last few days we have had showers, but they have not been equally general nor heavy enough. The rainfall of November was from 9 to 10 inches; this month it will not average half as much, and in the Leeward Parishes not a third. We hear bad accounts of the crops in St. Lucy and St. Peter, and not much better on the Southern Coast including St. Philip and Christ Church. As one goes inwards they improve, but the canes are low, and much depends on the kind of weather that we shall have in the next two months to insure a good yield. Under the most favourable circumstances we cannot expect to go beyond the crop reaped last year, about 40,000 hhds. Planters are now engaged planting the young crop, for which plants are in demand. As the stranger passes along the highway he is struck with the high state of cultivation everywhere to be seen, the fields without a weed or grass in them, thoroughly tilled and highly manured, ready for planting.—*The West Indian.*

# CROPS IN NATAL.

Our last monthly report was dated 24th ult., since which the weather has continued unsettled, frequent rains greatly retarding operations at the sugar mills, besides obstructing transport. Crushing has, therefore, only been conducted under difficulties, it being imposible to preserve fuel dry in any quantity for firing purposes, the great difficulty with the planters at the moment. Last year at this time sugar was coming in freely. Nor has the temperature been up to the mark yet this season which, so far, has been an exceptional one. Ratoons, new cane, and the maize crops in the low-lying situations, are not so forward either in their growth as might have been expected. The coffee plantations are also backward, from the same cause, no doubt. There has been abundance of bud, but it is only just coming into blossom. A short spell of dry sunny weather will soon, however, remedy all defects, and if not followed up by drought, agricultural prospects are favourable enough.

We are glad to find that in addition to the acreage more recently put under cane at the Umgeni and the Umhlanga, a field of six hundred acres is going in near the latter, the belt of bush land lying along the coast, between these two rivers, having proved wonderfully well adapted for the cultivation of sugar. Were it not for the uncertainty as regards labour, a much greater breadth of cane would be planted. But with Kafir wages up to 15s. per month, or even more, and planters bidding against each other to obtain hands, people naturally hesitate before entering on more extended enterprise. From up-country it is satisfactory to hear that fibres are again attracting attention, especially China grass, which, as Dr. Sutherland, Mr. Fenton, and others have demonstrated, grows luxuriantly. The *Agave Sisalana* is another product to which notice has been attracted, being found to thrive along the coast. The coast cultivation of ground nuts is also likely to come into vogue again, returns even from the crude appliances now used in the extraction of oil having of late proved very satisfactory.

Once a reliable source of labour supply is established, there can be no question that Natal will be found to afford ample resources for the employment of capital and machinery, all that are wanting in order to open up these and other industries as yet undeveloped.

Produce from the interior is dropping in, but nothing like what would be the case were traffic easier. With our highways in the state they are, the difficulties in the way of locomotion are frightful, and the want of the iron horse becomes more and more felt. How the planters are to get their crops to the port for shipment in anything like reasonable time, is every day becoming more and more a problem.

EXPORTS.—A steady business is reported during the month, restricted owing to arrivals of coast and up-country produce having been on a comparatively limited scale, the reasons for which are explained above.

SUGAR.—Large orders are to hand, which have only been very partially executed for want of stock. No matter how ample the crops on the fields, the planters have found it imposible to manufacture, and had they been able to effect this, the state of the roads is such that they could not have brought their sugar to market. If it be true, as reported, that the yield this season is to be a short one, and that the quantity available for export will fall below previous years, there seems to be no prospect of lower prices.

We still quote :—

| | | | | |
|---|---|---|---|---|
| White Crystals (vacuum pan), 1st quality | 31/0 | at | 32/0 | per cwt. |
| White Crystals, do., 2nd quality | 29/6 | ,, | 30/0 | ,, |
| White Crystals (Wetzel pan) | 27/0 | ,, | 28/0 | ,, |
| Light yellow Crystals | 24/0 | ,, | 25/6 | ,, |
| Light yellow counters | 23/0 | ,, | 24/0 | ,, |
| Yellow ordinary | 21/0 | ,, | 21/6 | ,, |
| Grey, dry and grainy | 21/0 | ,, | 22/0 | ,, |
| Syrups, best light | 19/0 | ,, | 20/0 | ,, |
| Do., dark, yellow, and brown | 18/0 | ,, | 18/6 | ,, |
| Do., low brown | 16/6 | ,, | 17/6 | ,, |

*Natal Trade and Shipping Circular*

## COMMERCIAL & OTHER STATISTICS OF THE UNITED KINGDOM.

*From Francis Reid & Co.'s Monthly Circular, January, 1873.*

| Year | Estimated Population, 31st Dec | Sugar Raw & Refined |  | Molasses |  | Tea |  | Coffee |  | Cocoa |  |
|---|---|---|---|---|---|---|---|---|---|---|---|
|  |  | Tons | Lbs. per Head | Tons | Lbs. per Head | Lbs. | Per Head | Lbs. | Per Head | Lbs. | Per Head |
| 1846 | 28,189,000 | 261,933 | 20·81 | .. | .. | 46,740,344 | 1·65 | 36,754,554 | 1·30 | 2,951,206 | 0·10 |
| 1847 | 28,093,000 | 290,282 | 23·14 | .. | .. | 46,314,821 | 1·65 | 37,441,373 | 1·33 | 3,079,198 | 0·11 |
| 1848 | 27,855,000 | 309,424 | 24·88 | .. | .. | 48,734,789 | 1·75 | 37,077,546 | 1·37 | 2·919,591 | 0·10 |
| 1849 | 27,632,000 | 299,041 | 24·24 | 31,853 | 2·58 | 50,021,576 | 1·81 | 34·399·374 | 1·24 | 3,206,746 | 0·12 |
| 1850 | 27,423,000 | 310,391 | 25·35 | 40,653 | 3·32 | 51,172,302 | 1·87 | 31,166,358 | 1·14 | 3,080,641 | 0·11 |
| 1851 | 27,529,000 | 328,581 | 26·74 | 45,915 | 3·73 | 53,949,059 | 1·96 | 32,504,545 | 1·18 | 2,978,344 | 0·11 |
| 1852 | 27,570,000 | 358,643 | 29·14 | 38,662 | 3·14 | 54,713,034 | 1·98 | 34,978,432 | 1·27 | 3,328,527 | 0·12 |
| 1853 | 27,663,000 | 374,379 | 30·32 | 39·997 | 3·24 | 58,834,087 | 2·13 | 36,983,122 | 1·34 | 3,997,198 | 0·14 |
| 1854 | 27,788,000 | 416,620 | 33·58 | 42,336 | 3·41 | 61,953,041 | 2·23 | 37,350,924 | 1·34 | 4,452,529 | 0·16 |
| 1855 | 27,899,000 | 384,267 | 30·86 | 46,126 | 3·45 | 63,429,286 | 2·27 | 35,764,564 | 1·28 | 4,383,023 | 0·16 |
| 1856 | 28,154,000 | 374,978 | 29·69 | 47·111 | 3·75 | 63,272,212 | 2·25 | 34,995,944 | 1·24 | 3,634,135 | 0·13 |
| 1857 | 28,359,000 | 382,294 | 30·20 | 30,556 | 2·41 | 69,130,482 | 2·44 | 34,367,484 | 1·21 | 2,656,233 | 0·09 |
| 1858 | 28,566.000 | 450,203 | 35·30 | 43,829 | 3·44 | 73,217,484 | 2·57 | 35,338,111 | 1·24 | 3,071,115 | 0·11 |
| 1859 | 28,774,000 | 457,449 | 35·61 | 34,890 | 2·72 | 76,362,008 | 2·65 | 34,492,947 | 1·20 | 3,480,987 | 0·12 |
| 1860 | 28,944,000 | 448,070 | 34·61 | 27,998 | 2·58 | 76,859,428 | 2·66 | 35,674,381 | 1·23 | 3,481,484 | 0·12 |
| 1861 | 29,196,000 | 478,040 | 36·06 | 54,500 | 4·18 | 77,949,465 | 2·67 | 35,375,675 | 1·21 | 3,576,384 | 0·12 |
| 1862 | 29,400,000 | 485,856 | 37·24 | 55,840 | 4·22 | 78,817,060 | 2·68 | 34,664,155 | 1·18 | 3,926,500 | 0·13 |
| 1863 | 29,600,000 | 495,050 | 37·46 | 37,452 | 2·83 | 85,206,776 | 2·88 | 32,986,116 | 1·11 | 4,106,468 | 0·14 |
| 1864 | 29,820,000 | 499,604 | 37·53 | 25,341 | 1·90 | 38,637,099 | 2·98 | 31,591,122 | 1·06 | 4,171,082 | 0·14 |
| 1865 | 30,000,000 | 545,781 | 40·75 | 28,692 | 2·14 | 97,921,944 | 3·26 | 30,748,349 | 1·02 | 4,286,635 | 0·14 |
| 1866 | 30,050,000 | 559,166 | 41·68 | 32,285 | 2·41 | 102,325,067 | 3·41 | 30,944,363 | 1·03 | 4,606,997 | 0·15 |
| 1867 | 30,200,000 | 593,358 | 44·01 | 20,186 | 1·50 | 111,057,705 | 3·68 | 31,567,760 | 1·05 | 4,585,517 | 0·15 |
| 1868 | 30,450,000 | 561,135 | 41·03 | 37,379 | 2·75 | 106,918,118 | 3·51 | 30,608,464 | 1·01 | 5,730,223 | 0·19 |
| 1869 | 30,750,000 | 583,369 | 42·17 | 37,088 | 2·70 | 111,889,118 | 3·64 | 29,109,113 | 0·94 | 6,564,216 | 0·21 |
| 1870 | 31,100,000 | 666,368 | 48·00 | 35,790 | 2·50 | 117,622,575 | 3·78 | 30,629,710 | 0·99 | 6,943,109 | 0·21 |
| 1871 | 31,500,000 | 702,201 | 49·93 | †34,181 | 2·43 | 123,529,642 | 3·92 | 31,010,645 | 0·98 | 7,333,988 | 0·23 |
| 1872 | 31,750,000 | 715,400 | 50·47 | †41,015 | 2·19 | 127,792,412 | 4·02 | 31,661,311 | 1·00 | 7,853,165 | 0·25 |

## Commercial and other Statistics of the United Kingdom.

| Year. | RICE | | TOBACCO | | TALLOW | | WINE | | BRITISH & FOREIGN SPIRITS | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Tons. | Lbs. per Head. | Lbs. | Per Head | Tons | Lbs. per Head | Gallons | Per Head | Gallons | Per Head |
| 1846 | 21,691 | 1·72 | 26,859,788 | 0·95 | 59·192 | 4 70 | 6,740,316 | 0·24 | 28,344,746 | 1·01 |
| 1847 | 55,166 | 4·40 | 26,638,136 | 0·95 | 53,465 | 4·26 | 6·053,847 | 0·22 | 25,534,820 | 0·91 |
| 1848 | 19,519 | 1·57 | 27,194,368 | 0·98 | 70,336 | 5·66 | 6,136,547 | 0·22 | 26,822,175 | 0·96 |
| 1849 | 25,474 | 2·06 | 27,553,238 | 1·00 | 70,624 | 5·72 | 6,251,862 | 0·23 | 28,216,149 | 1·02 |
| 1850 | 20,051 | 1·63 | 27,584,406 | 1·01 | 60·231 | 4·92 | 6,437,222 | 0·23 | 28,653,695 | 1·04 |
| 1851 | 19,173 | 1·56 | 27,915,024 | 1·01 | 54·049 | 4·40 | 6,279,759 | 0·23 | 28,742,691 | 1·04 |
| 1852 | 27,601 | 2·24 | 28,418,568 | 1·03 | 58,616 | 4·76 | 6,346,061 | 0·23 | 30,051,189 | 1·09 |
| 1853 | 38,917 | 3·15 | 29,564,695 | 1·07 | 66,848 | 5·41 | 6,813,830 | 0·24 | 30,151,075 | 1·09 |
| 1854 | 41,748 | 3·36 | 30,391,841 | 1·09 | 38,001 | 3 06 | 6,776,086 | 0·24 | 30·998,057 | 1·12 |
| 1855 | 48,345 | 3·88 | 30,332,657 | 1·09 | 39,714 | 3·19 | 6,296,439 | 0·23 | 26,731,609 | 0·92 |
| 1856 | 71,032 | 5·65 | 32,413,000 | 1·15 | 50·366 | 4·07 | 7,004,953 | 0·25 | 28,284,989 | 1·00 |
| 1857 | 74,523 | 5·85 | 32,680,369 | 1·15 | 53·586 | 4·20 | 6,605,710 | 0·23 | 28,864,186 | 1·02 |
| 1858 | 88,093 | 6·91 | 34,110,851 | 1·19 | 61,259 | 4·80 | 6,697,224 | 0·23 | 27,774,347 | 0·97 |
| 1859 | 65,334 | 5·09 | 34,791,261 | 1·21 | 51,825 | 4·03 | 7,262,965 | 0·25 | 28,790,364 | 1·00 |
| 1860 | 76,778 | 5·94 | 35,412,845 | 1·22 | 71,049 | 5·50 | 7,358,189 | 0·25 | 27,066,125 | 0·94 |
| 1861 | 79,172 | 6·07 | 34,976,453 | 1·20 | 57,596 | 4·42 | 10,787,091 | 0·37 | 25,097,640 | 0·86 |
| 1862 | 132,357 | 10·08 | 35,614,985 | 1·21 | 48,519 | 3·70 | 9,803,046 | 0·33 | 24,720,614 | 0·84 |
| 1863 | 73,225 | 5·54 | 37,616,246 | 1·27 | 56,333 | 4·26 | 10,478,057 | 0·35 | 24,718,991 | 0·84 |
| 1864 | 80,518 | 6·05 | 38,239,521 | 1·28 | 49,300 | 3·70 | 11,456,715 | 0·38 | 26,544,650 | 0·89 |
| 1865 | 27,264 | 2·04 | 39,179,801 | 1·36 | 66·015 | 4·93 | 12,061,386 | 0·40 | 26,990,464 | 0·90 |
| 1866 | 48,726 | 3·63 | 40,995,161 | 1·36 | 64,518 | 4·81 | 13,327,916 | 0·44 | 29,769,868 | 0·99 |
| 1867 | 78,868 | 5·85 | 41,053,612 | 1·36 | 52·076 | 3·86 | 13,754,343 | 0·45 | 29,090,697 | 0·96 |
| 1868 | 134,729 | 9·91 | 41,280,001 | 1·36 | 57,163 | 4·02 | 15,151,741 | 0·50 | 28,610,658 | 0·94 |
| 1869 | 175,038 | 12·75 | 41,719,500 | 1·36 | 59·056 | 4·30 | 14,840,158 | 0·48 | 29,624,124 | 0·96 |
| 1870 | 92,802 | 6·72 | 41,717,012 | 1·34 | 77,879 | 5·32 | 15,168,321 | 0·50 | 31,707,609 | 1·02 |
| 1871 | 103,649 | 7·37 | 42,775,334 | 1·36 | 67·630 | 4·81 | 16·237,756 | 0·52 | 34,454,883 | 1·09 |
| 1872 | 189,796 | 13·39 | 43,948,427 | 1·38 | 60,644 | 4·28 | 16,873,955 | 0·53 | 34,530,835* | 1·09 |

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* Consumption of British Spirits estimated at 25,500,000 gallons.

## Commercial and other Statistics of the United Kingdom.

| Year | Foreign Wool | | Cotton | | Raw Silk | | Total Value of Importations | |
|---|---|---|---|---|---|---|---|---|
| | Lbs. | Per Head | Lbs. | Per Head | Lbs. | Per Head | £ | Per Head |
| 1846 | 62,243,482 | 2·31 | 401,925,570 | 14·23 | 4,190,054 | 0·15 | Value not ascertained prior to 1856. | |
| 1847 | 57,782,873 | 2·23 | 399,753,295 | 14·23 | 3,697,187 | 0·13 | | |
| 1848 | 64,289,263 | 2·54 | 639,000,369 | 22·94 | 4,181,027 | 0·15 | | |
| 1849 | 64,318,150 | 2·33 | 656,575,476 | 23·76 | 4,518,132 | 0·16 | | |
| 1850 | 59,938,104 | 2·19 | 561,107,165 | 20·46 | 4,385,097 | 0·10 | | |
| 1851 | 69,581,988 | 2·53 | 645,399,389 | 23·44 | 4,059,449 | 0·15 | | |
| 1852 | 32,444,525 | 2·99 | 817,898,144 | 29·67 | 5,129,231 | 0·19 | | |
| 1853 | 107,671,080 | 3·89 | 746,709,069 | 27·00 | 6,046,852 | 0·22 | | |
| 1854 | 81,612,732 | 2·94 | 764,007,037 | 27·49 | 6,439,104 | 0·23 | | |
| 1855 | 69,846,980 | 2·50 | 767,383,792 | 27·51 | 4,433,307 | 0·16 | | |
| 1856 | 89,531,599 | 3·18 | 877,225,440 | 31·10 | 5,945,074 | 0·21 | 172,544,154 | 123/2 |
| 1857 | 93,262,679 | 3·29 | 837,391,296 | 29·53 | 10,371,306 | 0·37 | 187,844,441 | 133/5 |
| 1858 | 100,037,181 | 3·50 | 884,732,576 | 30·97 | 3,963,057 | 0·14 | 164,583,832 | 116/0 |
| 1859 | 104,267,884 | 3·62 | 1,050,845,836 | 36·52 | 7,768,564 | 0·27 | 179,182,355 | 125/5 |
| 1860 | 117,633,210 | 4·06 | 1,140,510,112 | 39·40 | 6,024,654 | 0·21 | 210,530,873 | 147/0 |
| 1861 | 92,795,737 | 3·18 | 958,696,816 | 32·84 | 4,613,689 | 0·16 | 217,485,024 | 150/2 |
| 1862 | 123,840,673 | 4·21 | 309,258,656 | 10·52 | 5,089,407 | 0·17 | 225,716,976 | 154/7 |
| 1863 | 113,449,703 | 3·83 | 428,230,768 | 14·47 | 5,368,226 | 0·18 | 248,919,020 | 169/5 |
| 1864 | 150,539,306 | 5·05 | 648,602,416 | 21·75 | 1,733,271 | 0·06 | 274,952,172 | 186/0 |
| 1865 | 129,761,317 | 4·33 | 675,069,360 | 22·75 | 4,586,260 | 0·15 | 271,072,285 | 182/2 |
| 1866 | 172,785,201 | 5·75 | 988,177,568 | 32·88 | 3,488,711 | 0·12 | 295,290,274 | 197/2 |
| 1867 | 142,951,240 | 4·73 | 911,910,496 | 30·17 | 3,947,634 | 0·13 | 275,183,137 | 182/6 |
| 1868 | 147,673,844 | 4·85 | 1,005,463,536 | 33·02 | 4,105,882 | 0·13 | 294,460,214 | 194/0 |
| 1869 | 141,853,383 | 4·61 | 948,298,512 | 30·81 | 2,524,215 | 0·08 | 295,460,214 | 192/1 |
| 1870 | 166,819,579 | 5·36 | 1,099,751,092 | 35·36 | 3,638,782 | 0·12 | 303,257,493 | 195/0 |
| 1871 | 184,421,512 | 5·73 | 1,406,281,520 | 44·64 | 4,961,500 | 0·16 | 330,754,359 | 210/0 |
| 1872 | 165,397,521 | 5·21 | 1,142,620,304 | 36·30 | 3,949,890 | 0·12 | 353,375,740 | 222/7 |

## COMMERCIAL AND OTHER STATISTICS OF THE UNITED KINGDOM.

| Year | Total Value of British and Irish Produce Exported | | Ships in Foreign Trade Entered Inwards | | Railways in United Kingdom | | |
|---|---|---|---|---|---|---|---|
| | £ | Per Head | Tonnage | Per Head | Capital Expended | Per Head | Nett Profit ⅌ cent. |
| 1846 | 57,786,876 | 41/0 | 6,101,015 | 0·22 | 87,765,100 | 62/3 | 5·25 |
| 1847 | 58,842,377 | 41/11 | 7,196,033 | 0·26 | 114,728,000 | 81/0 | 4·09 |
| 1848 | 52,849,445 | 37/11 | 6,525,945 | 0·23 | 154,200,000 | 110/9 | 4·06 |
| 1849 | 63,596,025 | 46/4 | 6,919,900 | 0·25 | 197,000,000 | 142/7 | 3·44 |
| 1850 | 71,367,885 | 52/1 | 7,100,476 | 0·26 | 230,522,730 | 168/3 | 3·31 |
| 1851 | 74,448,722 | 54/1 | 7,872,094 | 0·28 | 236,841,420 | 172/1 | 3·67 |
| 1852 | 78,076,854 | 56/8 | 7,887,447 | 0·29 | 248,083,520 | 179/11 | 3·44 |
| 1853 | 98,933,781 | 71/6 | 8,943,107 | 0·32 | 263,636,320 | 190/7 | 3·80 |
| 1854 | 97,184,726 | 69/11 | 9,160,366 | 0·33 | 273,860,000 | 197/1 | 3·93 |
| 1855 | 95,688,085 | 68/7 | 8,951,239 | 0·32 | 293,903,000 | 210/8 | 3·90 |
| 1856 | 115,826,948 | 82/3 | 10,553,134 | 0·38 | 302,946,260 | 215/3 | 4·00 |
| 1857 | 122,155,237 | 86/2 | 11,475,199 | 0·40 | 311,153,670 | 219/5 | 4·19 |
| 1858 | 116,608,756 | 81/8 | 10,961,700 | 0·38 | 319,950,000 | 224/0 | 3·91 |
| 1859 | 130,411,529 | 90/4 | 11,221,922 | 0·39 | 328,219,100 | 228/2 | 4·13 |
| 1860 | 135,891,227 | 93/11 | 12,172,785 | 0·42 | 337,827,200 | 233/5 | 4·39 |
| 1861 | 125,102,814 | 85/8 | 13,179,589 | 0·45 | 352,386,100 | 241/4 | 4·30 |
| 1862 | 124,137,812 | 84/5 | 13,091,000 | 0·44 | 370,107,280 | 251/9 | 4·22 |
| 1863 | 146,602,342 | 99/1 | 13,256,063 | 0·45 | 387,246,200 | 270/8 | 4·25 |
| 1864 | 160,436,302 | 107/7 | 13,515,011 | 0·45 | 408,396,680 | 273/11 | 4·49 |
| 1865 | 165,862,402 | 115/1 | 14,317,886 | 0·48 | 433,558,100 | 289/0 | 4·46 |
| 1866 | 188,827,785 | 125/8 | 15,612,170 | 0·52 | 463,746,800 | 318/8 | 4·29 |
| 1867 | 181,183,971 | 120/0 | 14,827,617 | 0·49 | 479,167,300 | 317/4 | 4·18 |
| 1868 | 179,463,644 | 118/0 | 13,851,317 | 0·46 | 486,893,400 | 319/10 | 4·13 |
| 1869 | 190,045,230 | 123/7 | 14,485,945 | 0·47 | 490,950,770 | 319/4 | 4·45 |
| 1870 | 199,586,822 | 128/1 | 14,910,742 | 0·48 | 504,381,000 | 324/4 | 4·49 |
| 1871 | 223,066,162 | 141/1 | 16,455,342 | 0·52 | 520,400,000 | 330/5 | 4·69 |
| 1872 | 255,961,609 | 161/3 | 17,902,783 | 0·56 | 537,285,640 | 338/5 | 4·83 |

## Commercial and other Statistics of the United Kingdom.

| Year | Declared Value of Gold, Silver, and Specie | | | | Bank Interest | Income Tax | |
|---|---|---|---|---|---|---|---|
| | Imported | Per Head | Exported | Per Head | An.avage per cent. | Nett Amount Assessed for Property and Profits | Per Head |
| 1846 | Not Registered prior to 1858. | | 2,937,266 | 2/1 | 3·33 | | |
| 1847 | | | 8,602,597 | 6/1 | 5·15 | | |
| 1848 | | | 8,596,990 | 6/2 | 3·69 | | |
| 1849 | | | 8,912,467 | 6/5 | 2·95 | | |
| 1850 | | | 6,940,346 | 5/1 | 2·51 | | |
| 1851 | | | 9,059,551 | 6/7 | 2·99 | | |
| 1852 | | | 10,295,464 | 7/6 | 2·24 | | |
| 1853 | | | 18,906,755 | 13/8 | 3·43 | | |
| 1854 | | | 22,586,568 | 16/3 | 5·11 | | |
| 1855 | | | 18,828,178 | 13/6 | 4·78 | | |
| 1856 | | | 24,851,797 | 17/8 | 5·83 | 268,338,109 | 190/7 |
| 1857 | | | 33,566,968 | 23/8 | 6·66 | 274,114,003 | 193/4 |
| 1858 | 29,493,190 | 20/8 | 19,628,876 | 13/9 | 3·03 | 292,694,508 | 204/11 |
| 1859 | 37,070,156 | 25/9 | 35,688,803 | 24/10 | 2·74 | 293,666,988 | 204/1 |
| 1860 | 22,978,196 | 15/11 | 25,534,768 | 17/8 | 4·18 | 299,232,878 | 206/9 |
| 1861 | 18,747,045 | 12/10 | 20,811,648 | 14/3 | 5·21 | 301,345,865 | 206/5 |
| 1862 | 31,656,476 | 21/6 | 29,326,191 | 19/11 | 5·53 | 317,070,986 | 215/8 |
| 1863 | 30,030,794 | 20/3 | 26,544,040 | 17/11 | 4·40 | 323,949,129 | 218/11 |
| 1864 | 27,728,276 | 18/7 | 23,157,515 | 15/6 | 7·35 | 326,696,050 | 219/1 |
| 1865 | 21,462,211 | 14/4 | 15,210,994 | 10/2 | 4·75 | 349,301,654 | 232/10 |
| 1866 | 34,287,139 | 22/9 | 21,970,687 | 14/5 | 6·90 | 364,430,553 | 248/6 |
| 1867 | 23,821,047 | 15/9 | 14,327,289 | 9/6 | 2·54 | 374,342,902 | 247/11 |
| 1868 | 24,852,595 | 16/4 | 20,220,014 | 13/3 | 2·10 | 386,542,366 | 253/11 |
| 1869 | 20,500,901 | 13/4 | 16,391,999 | 10/8 | 3·20 | 389,421,002 | 253/3 |
| 1870 | 29,455,668 | 18/11 | 18,334,450 | 12/2 | 3·04 | 398,222,811 | 256/1 |
| 1871 | 38,140,327 | 24/3 | 33,760,671 | 21/5 | 2·88 | 419,850,798 | 266/7 |
| 1872 | 29,505,319 | 18/7 | 30,335,861 | 19/1 | 4·10 | Not yet Published. | |

## THE INTERNATIONAL SUGAR QUESTION.

The prospect of the final success of the British Refiners, in their efforts to re-establish the Sugar Convention on a sound basis, does not look so bright as it did last month. The great deficiency in the receipts from the sugar duties in France, was then, apparently overcoming all other considerations. A great exposure had just been made in the National Assembly of the true cause of this great loss, and the proposal for the immediate adoption of refining in bond which resulted from that discussion was at once referred by the Assembly to the consideration of the Sugar Commission. On further consideration, however, the ardent partisans of this proposal began to think that its adoption, without some international arrangement, would hardly be desirable. The opponents of such a measure have on their side endeavoured to prove that the losses to the Treasury come from other causes than that of bounties on exportation. On the 24th January, a long discussion took place in the French Assembly, as to when the new law of Correlation should come on for consideration, and finally February 3rd was fixed. The French Government, which makes no effort to conceal its opposition to the proposal for the supervision of the refineries, tried to lead the Assembly to believe that the proposed law of Correlation is sufficient to restore the deficiency in the receipts. A mere statement of the Minister of Commerce that such would be the case, seems to have had some effect on the members. It ought to have been explained at once by those who understood the subject, that the effect of the proposed law would be to give the same bounties which are now only received on the exported sugar, to all the sugar going into consumption, thus more than doubling the present loss to the Treasury from that source; and that the provision in the proposed law, on which so much stress was laid, for the use of analysis as an assistance in doubtful cases, would be practically useless, or nearly so, especially as the law distinctly lays down that it is only to apply to sugar at the extreme limit of each class. It is to be feared, however, that unless this be distinctly explained to the Assembly, on February 3rd, they may take the authoritative statement of the Minister to be correct, and pass the law of Correlation, in the belief that they are thereby saving the Treasury from a further loss of 65 million francs in 1873.

The passage of this law will be a very serious blow to the cause of those who wish for the establishment of an international system of refining in bond, since it will amount to a further development in France of the classification of sugar by colour, for which refining in bond is proposed as a substitute. The French Government, and all who are opposed to refining in bond, will argue, with some show of reason, that the National Assembly could not be asked to render useless a law which it had just passed, by the adoption of a new system. There is one flaw about the proposed law of Correlation which gives a chance that it may still miscarry. It interpolates a new classification for sugars above No. 18, with a new and arbitrary yield of 96. This is introduced in order to provide for the white crystals of the beetroot factories, which at present, contrary to all the stipulations of the Convention, are admitted into the refineries at a duty 3fr. less than that on refined, and which would, without the intervention of this new classification, be placed under a strictly accurate law of Correlation, in the same category with other refined. This, of course, is where they were intended to be by the terms of the Convention, and where they have always been placed in this country. It is just possible that the English Government may be alive to this stratagem and frustrate it, though the hope is but a slender one, when we remember that the French law of 1864, which placed the white crystals in their present illegal position, was made (so to speak) under the very eyes of the English delegates at the Conference, and was never discovered till it was too late.

The debate of January 24th, in the National Assembly, shows clearly that the French Government is as little disposed, as were its representatives at the Conference, to adopt the only system which can stop bounties on exportation, and restore equilibrium to its budget. It clearly prefers the interests of its refiners to the increase of its revenue. This is the only inference which can be drawn from what passed on that occasion, unless, indeed, as is quite possible, the French Government be grossly misinformed on the subject. It is also remarkable to notice how completely it seems to ignore the results of the very important inquiry which was made into the whole question last summer by its orders,—results which are now published in two very thick blue books, every line of which goes to prove the soundness of M. Pouyer Quertier's opinion, who it must be recollected presided with great care and impartiality over that inquiry. This gentleman again points out to the Assembly the real state of the case, and as his remarks always appear to command great attention, there is still some hope that his views may prevail. He is evidently quite convinced by the evidence which was given before him that no system but that of refining in bond will protect the revenue. An impartial opinion formed on such a basis ought to carry great weight in the Assembly. Unfortunately, it seems to stand alone. There are other strong advocates for the same course, but they are accused of advocating the cause of the producers in hostility to the refiners. It is the Government which ought in such a case to intervene, and make the matter quite clear to the Assembly. Instead, however, of supporting the views of the eminent President of the Council appointed by it, who would naturally be presumed to be well informed on the matter, the Government does all it can to throw cold water on his statements. It remains to be seen who will eventually succeed in gaining the adhesion of the Assembly. Some small comfort may in the meantime be drawn from a statement made in this debate, that the Commission which is about to report on the *projet de loi* for refining in bond, which was hurriedly proposed, and referred to it, in the short discussion before Christmas, "will ask the Government to request another Conference, with a view to coming to a general agreement on the subject of refining in bond."

As France was the principal cause of the last Conference being abortive, such an invitation from it will indeed be a confession of the incompetence of its representatives.

France is the only one of the four powers which has failed to carry out the arrangement entered into at the Conference to report on the subject of assessment by analysis, by January, 1873. The reports received from Belgium and Holland, and from the chemists of our own Excise department are understood to be unfavourable to such a system.

## Correspondence.

### THE SLAVE TRADE IN POLYNESIA.

To the Editor of "The Sugar Cane."

Sir,

"The Slave Trade in Polynesia and Africa" is the title of an article in your number for July 1st, 1872, to which subject your attention has been called by the receipt of a small pamphlet reprinted from the *Brisbane Courier*, "Polynesian Labour and the Slave Trade in the Pacific," by J. De Poix Tyrel, J.P., Redland Bay, Queensland, and from which pamphlet you quote fully to show the high value, if not the absolute necessity, of Polynesian labour for sugar plantations in Queensland.

Being a Queenslander of nearly twenty years standing; and interested to some extent in its sugar industry, I would like through the pages of your magazine to enter my protest against the statements of Mr. De Poix Tyrel, and against any such conclusion being drawn from them. But before doing so, it will be necessary to explain that, although a subscriber to and reader of the *Brisbane Courier* from a date long anterior to the advent of Mr. De Poix Tyrel among us, I never heard of his pamphlet before seeing your article, although it may have had a considerable private circulation, and I have no recollection of having seen its contents in the *Courier*, unless they were included in one letter over that gentleman's signature.

The silent system is preferred by the aiders and abettors of Polynesian-cum-Queensland slavery. About a year ago, a meeting was called by private circular, by some of the planters of the Logan district, ostensibly to consider the labour question, but the real question was that of Polynesian labour. The firm which is by far the largest employer of European labour in the district, together with most others who confine themselves to that description of labour, having been omitted from among those to whom invitations were addressed, the firm now referred to, and a gentleman whose name is well known both in England and Queensland, Mr. Henry Jordan, formerly Agent General for Emigration in England, and who is also an employer of white labour only, were known to be among the most extensive and prosperous planters and manufacturers in the district, and yet one of the principal speakers was stated to have spoken "at some length upon the "value of Polynesian labour as an auxiliary to the working of a "sugar plantation, without which, he maintained, it would be "impossible to carry on any estate successfully;" of course a statement so flagrantly at variance with known facts, and so damaging to the character of the colony generally, although harmless in the locality where it was uttered, could not be allowed to be disseminated through the press without challenge, and the last of the correspondence on the subject was the letter of Mr. De Poix Tyrel, above referred to. Mr. De Poix Tyrel was then for a short time manager of the Redland Bay sugar plantation. Machinery was erected during his management for the manufacture of sugar, and his connection with the plantation and the sugar interest has since terminated.

You will therefore agree with me that those interested acted with judgment in not accepting as worthy of discussion the statements of a gentleman whose connection with the sugar interest was of so ephemeral a nature, and held by such an uncertain tenure. So much, however, of Mr. De Poix Tyrel's pamphlet as has been quoted in your article occupies a more important position, and requires a passing notice. I protest, therefore, against the statements and the conclusions drawn from them for the following reasons, which will at once commend themselves to all employers of labour here and elsewhere.

1st.—Good European labourers will not (as a rule) work on the same plantations with Polynesians if employment is obtainable where European labour only is used, consequently, inferior workmen only would constitute the European side of Mr. De Poix Tyrel's experiment.

2nd.—Europeans will not work for 20s. per week if the standard at the same time and in the same locality be 25s., and I know the firm already referred to were paying 25s. at the time; therefore, inferior workmen only would constitute the European side of Mr. De Poix Tyrel's experiment.

3rd.—Good European workmen always prefer permanent employment under a manager who is identified with and thoroughly understands his business. Mr. De Poix Tyrel estimates his permanent staff at five white men, while he had twelve in his experiment; and his own connection was of the most ephemeral nature, consequently the employment would only be temporary, and inferior workmen only would constitute the European side of Mr. De Poix Tyrel's experiment.

It is unnecessary further to consider Mr. De Poix Tyrel's "facts," except to state that £10 per annum to cover the cost of food, clothing, hut accommodation, medical attendance and medicine, is a low estimate for each Polynesian—particularly when we remember that the wages mentioned have to be paid whether the Polynesian works or not.

It is admitted by most employers that Polynesians are not cheaper than Europeans (of course, I am speaking of Southern Queensland), but that they are more to be depended on. The trashing of canes at which Polynesians presumably have the advantage is believed by careful calculating planters to be almost if not altogether unnecessary,—the aridity of our atmosphere, as compared with the humidity of that of the West Indies, preventing that retention at the joints and premature shooting of the buds which are so detrimental in the more humid climate, and the warmth afforded by the dead leaves in winter does good service against the frost, the worst enemy of the planter of Southern Queensland. A paragraph in the last monthly summary of the *Brisbane Courier*, gave the experience of the Messrs. Grimes, of Brisbane River, as being highly favourable to this view of the case. The firm above referred to have also reaped a crop this season, so treated, 6½ acres of which yielded 62 tons of cane to the acre, and from which 27 tons of sugar were manufactured; and Mr. Jordan who also favours that practice, and who, I believe, was the only anti-Polynesian exhibitor for the highest prize for sugar at the late show of the Agricultural Society of Southern Queensland, carried off their gold medal. None of these gentlemen employ Polynesians, all are cultivators and manufacturers, and yet for quality of sugar, quantity per weight of cane or acre of land, or for general progress, they are certainly not behind the majority of their fellow colonists. Mr. De Poix Tyrel admits that "a white man on contract work, such as clearing, fencing, or any other work, when the amount done determines the amount paid, will do more than a Polynesian." Now, much capital is attempted to be made by the statement that white men cannot work at out-door labour in Queensland, but clearing and fencing are the most severe portions of out-door labour connected with the establishment of a sugar plantation, and white men are better than Polynesians at these or any other contract work, but as nearly all the work can be done by contract there is very little real necessity for Polynesians. I could give you quantities of statistics as to the value of intelligent European labour, but will only refer to general results,—it is a notorious fact that the cases of extraordinary heavy expenditure in forming, and of unsuccessful endeavours to form, sugar plantations in Southern Queensland have largely preponderated on the side of the pro-Polynesian employers.

Mr. De Poix Tyrel, it appears, is silent as to the manner in which the Polynesians now employed are obtained. Wisely so. A judicious reticence on such a subject is commendable. But you suggest that, "if Queensland is to become a sugar-growing country, it will be needful for the Colonial Government to take in hand the immigration question." You may not be aware that the Government have already done so; that we have a Polynesian Labourers' Act now in force; that under it the schooner *Jason* lately arrived, 26 of her recruits dying soon after arrival; that on a previous occasion her then commander was tried for kidnapping, and received sentence of five years' imprisonment; that under that Act Polynesians are decoyed on board, and taken to the nearest or most profitable market. The Government have taken it in hand; but the Government—if not as such, at any rate through some of its members—is deeply interested in the traffic which has spoilt the fame and dishonoured the name of Queensland in the estimation of every other British community on the face of the earth. And, however paradoxical it may appear, the great majority of the colonists of Queensland are heartily glad that a power higher than the Government of Queensland have taken the matter in hand, and that it is the intention of the Imperial Government and Parliament to purge the nation of the charge of complicity with the malpractices of any of its dependencies in this nefarious traffic. The case of the officers and men of the brig *Carl*, now, I believe, *sub judice* in an adjoining colony, is another evidence of the means sometimes used to avoid the consequences, while obtaining the advantages, of this Polynesian recruiting. But it is needless to multiply evidence. All reasonable men are satisfied that the traffic has gone too far to be easily regulated; it can only be purged of its gross abuses by being annihilated. Why, according to Mr. De Poix Tyrel, the cost of passage is £15 each way; a sum equal to, if not in excess of, the cost of the passage of a European emigrant from Great Britain or Germany. "And why? Because the golden rule sufficeth them, the simple plan, that they should take who have the power, and they should keep who can." For on no other supposition could the cost of a Polynesian "immigrant" from the South Sea Islands equal that of a European immigrant from Europe.

Another article in your July number, on "The Expenses of Sugar Culture during Slavery," proves unmistakeably that the cost under that system was vastly greater than it is at present. £16 14s. per hogshead of sugar, "without charge for interest on slave or other capital invested," as against £8 to £10 at present; and that "it may safely be said that now as much sugar is made by one-half or two-thirds of the number of people it required during slavery." And if this be the case as between bond and free negroes, how much more so will it be as between "recruited" Polynesians and free European labourers; and what is the comparative advantage to the colony generally? The passage of each Polynesian costs £30 here and back, and he gives three years labour. The cost of a couple of European immigrants is the same, and they become permanent colonists, working for others until they can commence on their own account; and thus they and their children after them are a permanent benefit and credit to the colony. I say nothing about the great temptation that exists to reduce the Polynesian's passage money one-half, by his being dead or unaccounted for three years after his arrival. Of course it would be an abuse of the system, but we know that the system is liable to very gross abuse in many points; and the number under those heads is already far above the average over the whole population. And with returns at all approaching that given above, the sugar planters of Southern Queensland may fairly venture to give unto their servants that which is just and equal. (A parallel return appears in the first number of your magazine as having been obtained at the Pimpama plantation, in the same locality, so that

I have not taken any solitary case for illustration.) They may risk the employment of European labour, even in spite of the reckless assertion of Mr. De Poix Tyrel about the cost being double, rather than incur the odium and responsibility of encouraging a system fraught with such incalculable evils as is the present traffic in Polynesians. But "if there is no foundation for the assumption that the slave trade is inseparably connected with the immigration of Polynesians," there is just as little for the assumption that sugar culture requires other than European labour. The men who commenced here with very little capital, who could scarcely buy a dozen Polynesians if they wished to, who have progressed by their own industry and the employment of European labour, will make sugar culture in Southern Queensland an established fact, independent of Polynesians or the pro-Polynesian men, and will prove in the most satisfactory manner that the Polynesian delusion is an unnecessary, unprofitable, and unmitigated evil.

We never attack, but always defend when attacked by such assertions as those quoted.

Failing to find the name of Mr. De Poix Tyrel on the Queensland commission of the peace for 1872 (or any other time), I have omitted the honorary! initials.

William Fryar.

## PATENTS.

95,888. 24th July, 1872. Porison & Mehay, Wardreques, (Pas-de-Calais.) *Improvements in Evaporating and Treating Sweet Waters, called* Exosmose, *and other saccharine liquids of light density.*

95,936. 11th July. Cottle, 13, Rue Gaillon, Paris. *Improvements in Centrifugal Machines.*

95,965. 16th July. Clerc, 13, Boulevard St. Martin, Paris. *Improvements for purifying Syrups, obtained in the Manufacture and Refining of Sugar.*

96,164. 6th August. Le Comte de Chousy, 18, Place de la Bourse, Paris. *Improvements in the Manufacture of Loaf Sugar—by a cold process of clarification.*

96,174. 5th August. Langen, 95, Boulevard Beaumarchais, Paris. *Improvements in the Manufacture of Loaf Sugar.*

96,277. 17th August. Matrot, 47, Rue de la Roquette, Paris. *Improvements in Revivifying Char in a Vertical Retort Furnace.*

96,302. 31st August. Cunisset, Carrière St. Denis, (Seine & Oise,) Paris. *Improvements in the Manufacture of Sugar by the Treatment with Phenic acid.*

3,926. D. C. Miller, Lockhall, Lanarkshire, N.B. *Improvements in Distilling, Evaporating, or Concentrating Saccharine and other Solutions or Liquids.*

## EXPORTS OF SUGAR AND MOLASSES FROM HAVANA,

### During the Years 1872 and 1871.

| Destination. | Sugar. 1872. Boxes. | Sugar. 1872. Hhds. | Sugar. 1871. Boxes. | Sugar. 1871. Hhds. | Molasses. 1872. Hhds. | Molasses. 1871. Hhds. |
|---|---|---|---|---|---|---|
| United States | 512,640 | 40,393 | 453,811 | 33,163 | 21,855 | 21,715 |
| U. Kingdom and a market | 370,231 | 10,118 | 194,634 | 1,607 | 731 | 331 |
| Russia | 1,013 | .... | 5,055 | .... | .... | .... |
| Norway, Sweden, and Denmark | 18,948 | .... | 11,606 | .... | 50 | 52 |
| Hamburg and Bremen | 2,386 | 8 | 178 | 9 | .... | 133 |
| Holland | 250 | .... | 250 | 38 | .... | 375 |
| Belgium | 23,775 | .... | 18,048 | .... | .... | .... |
| France | 83,739 | .... | 40,066 | .... | .... | .... |
| Spain | 124,724 | 1 | 145,237 | 9 | 240 | 168 |
| Gibraltar, Italy, Adriatic & Mediterranean Ports | 3,840 | .... | 1,645 | .... | .... | .... |
| British Possessions N. A. | 136 | 542 | 2,746 | 10 | 1,654 | 250 |
| Mexico, S. America, &c. | 6,958 | 23 | 2,991 | 21 | 566 | 110 |
| Total to 27th Dec. inclusive | 1,149,640 | 51,085 | 876,267 | 34,857 | 25,096 | 24,956 |

## SUGARS AFLOAT.

|  | Cargoes. | January, 1873. Tons. | January, 1872. Tons. |
|---|---|---|---|
| From Mauritius to Channel | 27 | 14,560 | 12,501 |
| ,, ,, to Continent | 9 | 5,106 | 5,438 |
| ,, Java to Channel | 14 | 11,363 | 9,760 |
| ,, ,, to Holland | 24 | 14,266 | 3,190 |
| ,, ,, to Dutch Trading Company | — | 4,622 | 13,814 |
| ,, Manilla to London, L'pool., & Channel | 24 | 18,954 | 12,483 |
| ,, Calcutta to London and Liverpool | 3 | 112 | 542 |
| ,, Madras and Coast to London | 11 | 4,713 | 532 |
| ,, ,, ,, to Liverpool | 2 | 1,450 | 830 |
| ,, Singapore and Penang to London and Liverpool | 6 | 840 | 680 |
| ,, Bahia to Channel and United Kingdom | 14 | 4,363 | 2,020 |
| ,, Pernambuco to Channel & U. Kingdom | 5 | 912 | 1,000 |
| Totals |  | 81,261 | 62,790 |

## COLONIAL EXPORTS.

*(From Licht's Monthly Circular.)*

### MAURITIUS.

| From 1st Aug. to 12th Nov. | 1872-73. | 1871-72. | 1870-71. |
|---|---|---|---|
| | Tons. | Tons. | Tons. |
| To England | 14,400 | 12,898 | 5,591 |
| ,, France | 7,750 | 9,950 | 2,337 |
| ,, Australia | 13,942 | 7,547 | 11,127 |
| ,, New Zealand | 2,817 | 1,056 | 1,355 |
| ,, Cape of Good Hope | 708 | 397 | 1,037 |
| ,, Bombay | 3,096 | 14,653 | 8,663 |
| ,, Other Ports | 2,207 | 1,221 | 156 |
| Total | 44,920 | 47,722 | 30,266 |

### HAVANA AND MATANZAS.

| From 1st Jan. to 1st Dec. | 1872. | 1871. | 1870. |
|---|---|---|---|
| | Tons. | Tons. | Tons. |
| To Great Britain | 142,156 | 66,082 | 175,938 |
| ,, United States | 221,883 | 183,984 | 185,990 |
| ,, Spain | 37,785 | 45,656 | 59,395 |
| ,, France | 21,896 | 11,339 | 44,454 |
| ,, Northern Europe | 13,060 | 8,979 | 11,229 |
| ,, Southern Europe | 960 | 547 | 3,405 |
| ,, Other Ports | 5,188 | 3,382 | 8,176 |
| Total | 442,928 | 319,969 | 488,587 |
| Stocks in Havana and Matanzas | 14,137 | 19,624 | 13,040 |

### Stocks of Sugar in the Chief Markets of the World on the 1st December for Three Years, in thousands of tons, to the nearest thousand.

| | 1872. | 1871. | 1870. |
|---|---|---|---|
| Great Britain | 158 | 104 | 140 |
| France | 109 | 89 | 86 |
| Holland | 29 | 25 | 23 |
| Germany (Zollverein) | 27 | 25 | 27 |
| Six other *entrepôts* | 7 | 5 | 4 |
| Total in Europe | 330 | 248 | 280 |
| United States | 42 | 78 | 65 |
| Havana and Matanzas | 14 | 20 | 13 |
| Total | 386 | 346 | 358 |

### Consumption of Sugar in Europe and the United States, for Three Years ending 30th November, in thousands of tons.

| | 1872. | 1871. | 1870. |
|---|---|---|---|
| Great Britain | 709 | 679 | 690 |
| France | 261 | 290 | 321 |
| Germany (Zollverein) | 219 | 228 | 216 |
| Holland | 25 | 25 | 30 |
| Six other Countries | 88 | 118 | 106 |
| Total in Europe | 1,302 | 1,340 | 1,363 |
| United States | 578 | 522 | 468 |
| Total | 1,880 | 1,862 | 1,831 |

### Estimated Crop of Beet Root Sugar on the Continent of Europe, for the ensuing Season, compared with that of the three previous Seasons.

*(From Licht's Monthly Circular.)*

| | 1872-73. | 1871-72. | 1870-71. | 1869-70. |
|---|---|---|---|---|
| | Tons. | Tons. | Tons. | Tons. |
| France | 360,000 | 335,351 | 289,084 | 289,324 |
| Germany (Zollverein) | 255,000 | 189,166 | 262,986 | 217,192 |
| Austro-Hungary | 167,500 | 161,526 | 182,280 | 151,354 |
| Russia and Poland | 135,000 | 90,000 | 135,000 | 132,500 |
| Belgium | 75,000 | 72,236 | 55,739 | 43,552 |
| Holland and other Countries | 32,500 | 25,000 | 17,500 | 12,500 |
| Total | 1,025,000 | 873,279 | 942,589 | 846,422 |

# SUGAR STATISTICS—GREAT BRITAIN.

To 18th January, 1873 and 1872. In Thousands of Tons, to the Nearest Thousand.

| | STOCKS. | | | | | | IMPORTS. | | | | | | DELIVERIES. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. |
| British West India | 16 | 2 | 1 | 16 | 36 | 17 | 3 | 1 | 1 | 1 | 5 | 5 | 4 | 1 | 1 | 2 | 8 | 9 |
| British East India | 13 | 3 | .. | .. | 16 | 6 | 5 | .. | .. | .. | 5 | 2 | 1 | .. | .. | .. | 1 | 2 |
| Mauritius ...... | 5 | 1 | 1 | 1 | 8 | 7 | 2 | .. | 2 | .. | 4 | 3 | 1 | .. | 1 | .. | 2 | 2 |
| Cuba .......... | 3 | 1 | 1 | 9 | 14 | 9 | .. | .. | 1 | .. | 1 | 1 | 1 | .. | 1 | 1 | 3 | 2 |
| Porto Rico, &c. .. | 2 | 3 | .. | 1 | 5 | 3 | .. | .. | .. | 1 | 1 | .. | 1 | .. | .. | .. | 1 | 1 |
| Manilla & Java .. | 22 | 6 | .. | 1 | 29 | 23 | 1 | 1 | .. | .. | 2 | 4 | 1 | 1 | .. | 1 | 4 | 4 |
| Brazil .......... | 1 | 15 | .. | 5 | 22 | 13 | .. | 3 | .. | .. | 4 | 3 | .. | 2 | .. | 1 | 2 | 3 |
| Beetroot, &c. .... | 8 | 3 | 2 | 10 | 23 | 19 | 4 | 2 | 2 | 6 | 15 | 12 | 3 | 1 | 2 | 7 | 12 | 11 |
| Total, 1873 .. | 71 | 33 | 6 | 43 | 153 | 97 | 15 | 8 | 6 | 7 | 36 | 30 | 11 | 5 | 5 | 13 | 34 | 33 |
| Total, 1872 .. | 40 | 23 | 5 | 29 | 56 increase | | 10 | 5 | 3 | 12 | 6 increase | | 11 | 8 | 3 | 12 | 1 increase | |

## STATE AND PROSPECTS OF THE SUGAR MARKET.

During the past month, markets for all descriptions of raw and refined sugars have been greatly depressed, and prices generally have ruled lower.

Contrary to usual precedent at this season, stocks of raw sugar have continued to increase during the month, and are now 56,000 tons in excess of those of the same date in 1872, and 29,000 tons above those of 1871.

Prices are now lower than during any part of last year. No. 12 Havana afloat for the United Kingdom is quoted at 27s. 6d. per cwt., and fair to good refining Cuba Muscovado at 24s. to 24s. 6d. per cwt., being 2s. to 2s. 6d. lower than a year ago. Middling to good Bahia is worth 20s. to 21s. per cwt., and good to fine Pernambucos 22s. to 23s. per cwt., a decline of 3s. 6d. to 4s. per cwt., compared with the same period in 1872.

The average duty paid price of refining qualities of British West India is 28s., and common refined lump 38s. to 38s. 6d. per cwt. in London, 2s. 6d. lower than a year ago.

The aggregate of the cargoes of raw sugar afloat from the Colonies for British and Continental ports is considerably larger than usual, and the prospects of the coming crops are generally favourable. Good accounts continue to be received from Cuba, Brazil, Java, Porto Rico, and Guadeloupe. From these Colonies full average crops may be expected, which will more than counterbalance the slight deficiencies anticipated in Réunion, Mauritius, and some of the British West India Islands.

The accounts of the Continental Beet-Sugar crop continue unchanged, and, notwithstanding the unfavourable state of the weather having materially affected the percentage of sugar produced from the root, M. Licht's estimate of the crop is still 150,000 tons above that of last season. It is said in some quarters that this large increase will not more than suffice for the greatly extended consumption of the Continent of Europe; and it is well known that in the United States new sources of supply are required to keep pace with the constantly increasing deliveries.

THE
SUGAR CANE.

No. 44. MARCH 1, 1873. Vol. V.

☞ The writers alone are responsible for their statements.

*For Table of Contents, see opposite the last page of each Number.*

# THE LIMITS OF THE CONSUMPTION OF SUGAR.

The remarkable expansion of the commerce and manufactures of this country, which dates from the adoption by its legislature of a free trade policy, has been accompanied by the development among its inhabitants of a power to consume articles of food, and notably sugar, that the most ardent disciples of Cobden and Bright could scarcely have suspected to lie dormant. If the economist of 1846 had prophesied that before twenty years should have elapsed, the amount of sugar consumed per head by the inhabitants of the United Kingdom would have been *doubled*, his predictions would have been considered wild and improbable. Yet this increase did actually take place, and after the lapse of another seven years this large consumption has still further been increased to the extent of twenty-five per cent. The amount of sugar consumed in any year is affected to some extent by its price, and this is dependent in part upon the amount of duty. As considerable fluctuations in price, and consequently of consumption, have at times occurred between one year and the following one, it is more easy to note the general rate of increase by taking a series of averages extending over three years, and comparing them. The following table shews the amount consumed per head in triennial periods since 1846, with the increase between each period and that preceding it.

| Three years' averages. | | Lbs. Sugar, raw and refined, consumed per head in U.K. | | Lbs. Increase. |
|---|---|---|---|---|
| 1846 alone | .... | 20·81 | .... | .. |
| 1846-8 | .... | 22·94 | .... | .. |
| 1849-51 | .... | 25·44 | .... | 2·5 |
| 1852-4 | .... | 31·01 | .... | 5·57 |
| 1855-7 | .... | 30·25 | .... | ·76 decrease. |
| 1858-60 | .... | 35·17 | .... | 4·92 increase. |
| 1861-3 | .... | 36·92 | .... | 1·75 |
| 1864-6 | .... | 39·99 | .... | 3·07 |
| 1867-9 | .... | 42·40 | .... | 2·41 |
| 1870-2 | .... | 49·46 | .... | 7·06 |
| 1872 alone | .... | 50·47 | .... | .. |

It is clear from these figures, that the consumption has rapidly and largely increased, but the rate of increase presents no uniform character. In one triennial period (1855-7), the consumption actually declined, and that this circumstance is not mainly traceable to the condition of the people, is to be inferred from the fact, that during the same three years, the consumption of tea had increased 2·32 lbs. per head, from 2·12 lbs. in the preceding three years.

A glance at the prices of sugar will suggest a reason for the diminished consumption. The *Gazette* average price of British plantation sugar at Midsummer, 1855, was twenty-two shillings. From that date it advanced; in the middle of September it reached thirty-one shillings; and in November the price was not less than forty-nine shillings. This checked consumption and produced a reaction, so that by the middle of February, 1856, the price had descended to within sixpence per hundredweight of that of the previous June. This depression soon passed away, and the price again rose. In June, thirty shillings was reached, and at the end of the year thirty-seven shillings was the quotation. Until Midsummer of 1857, the price continued to increase until forty shillings was reached, and then it gradually declined to about its normal point at the close of the year. This extraordinary condition of the market accounts for the falling off in consumption, without looking for other causes.

The very rapid increase in the consumption of sugar during recent years, is traceable to the low duties and lower prices, and also to the general prosperity of the industrial classes. The high price of butchers' meat, and of butter, and the greater cheapness of tea, in consequence of the low rate of duty, have doubtless stimulated the consumption.

The quantity of sugar eaten at the present time in the United Kingdom, is really enormous—*fifty-one pounds per head per annum.* Say a pound of sugar per week for each inhabitant. When it is borne in mind that a very large proportion of the inhabitants of Great Britain, and a still larger proportion of the inhabitants of Ireland are compelled, from the narrowness of their means, to practice close economy in the use of sugar, as of other articles of food, there is cause for surprise, that taking the whole population round, the rich and the very poor, adults, children and infants, inmates of gaols, workhouses, and asylums, one with another consume almost exactly one pound of sugar per week each. In order to appreciate this quantity, let us compare it with the generous dietary of the well nourished sailors, who man the navy of the United States. Each such sailor is furnished with fourteen ounces of sugar, and half a pint of molasses per week. If this be the consumption of an adult man, whose toil is great and exposure frequent, how very large the consumption of our people appears, when it includes probably forty per cent. of children under five years of age. The inhabitants of the United States consumed thirty-nine lbs. of sugar per head, in 1872.

No amount of prosperity can fairly be expected to raise the consumption to a higher point than will be reached in a family of the middle class, where sugar is freely used without stint, in the same manner as bread, potatoes, or salt. In such a family of eight, including children, (no infants) adults, and domestic servants, the consumption of sugar for last year was sixty-seven pounds per head. This included a small portion of golden syrup; (about one ounce per head) and also included all the sugar used in preserves and confectionery. From these figures we cannot fairly expect to see the amount of sugar used for human food at any time to surpass the present rate by twenty pounds per head.

## FRENCH BEETROOT SUGAR MANUFACTURE.

The following table shows the percentages of various qualities of sugar manufactured from beet root in France, during the seasons 1872-3, and 1871-2. It will be noticed that the contrast exhibits a marked increase in the production of the lower qualities this season.

| | 1872-3. | 1871-2. |
|---|---|---|
| Under No. 7 | 0·97 | — |
| ,, 7 to 9 | 22·83 | 5 |
| ,, 10 ,, 12 | 22·87 | 36 |
| ,, 13 ,, 14 | 15·35 | 5 |
| ,, 15 ,, 18 | 1·89 | 13 |
| ,, 19 ,, 20 | 0·12 | 2 |
| White Powder | 35·17 | 38 |
| Refined direct from the Root | 0·80 | 1 |
| | 100 | 100 |

A more careful examination of the table will well repay the trouble. The British sugar refiners have persistently urged that the present mode of assessing the sugar duties in France, taken in connection with the heavy rates of duty, tends to degrade the art of beet root sugar making to the art of escaping the sugar duty.

In order to do this, it is needful to darken the sugar in colour, so as to permit it to be classed with a lower standard than its saccharine richness would warrant. The foregoing table shows with great clearness, the extraordinary rapidity with which the lesson has been learnt by the beet-root sugar makers of France, in a single year. The finest raw sugars destined for refining, are now replaced by medium qualities, and the quantity of the lowest raw is largely increased by the sugars that hitherto have appeared in the higher and medium classes.

| | 1872-3. | 1871-2. |
|---|---|---|
| Low raw, under No. 7, and Nos. 7 to 9………… | 23·8 per cent. …… | 5 per cent. |
| Medium raw, Nos. 10 to 14. . | 38·22 ,, …… | 41 ,, |
| Fine raw, Nos. 15 to 18, and Nos. 19 to 20………… | 2·01 ,, …… | 15 ,, |

Thus *six-sevenths* of the finest raw have disappeared, and the lowest qualities have increased *five-fold.* Nothing could better confirm the position taken by the British refiners.

Last summer, the French Superior Council of Agriculture, when engaged in examining the condition of the sugar industry, and the effect produced upon it by the present mode of assessing the duties, listened incredulously to the representations made by the deputation of British Sugar Refiners, as to the darkening of the sugars in order to escape a portion of the duty. The extent to which this practice has been resorted to in French Beet root factories is becoming known, and even the eyes of the Excise authorities are now open to this evasion of the duty. The following circular has been issued by M. Provensal.

"Sugars.—Instructions to the Heads of the Department.—By its circulars of the 5th April and of the 14th November last, the Administration has successively directed the attention of its officers to the different modes employed to conceal the real quality of sugars under a low tint of colour. Among substances used for this purpose, I have to point out the Hamelle charcoal, oxide of iron, and picric or pyrogallic acids. This last agent may be added during the boiling, not only without the knowledge of the officers, but even without the workman who is employed on the apparatus being aware of it. It communicates neither taste nor smell to pure water, nor to the 'liquor,' in which also it leave no trace whatever. Finally, the colour which it developes is only produced slowly, and by contact with the air. The Hamelle charcoal is introduced into the boilers in the state of a fine powder. It neutralises the salts even better than animal charcoal, facilitates the boiling, accelerates the crystallisation, and it is said, increases the yield, but it has none of the decolourising properties of animal charcoal, and indeed, without adding anything to the natural colour of the syrups, it allows the production of sugars with a very high strength, although of a very low colour. I have been told of an impalpable powder prepared by the oxidisation of aniline, which substance is made from the distillation of coal. This powder is soluble in water, which it colours slightly brown. Its colouring power is such that it is sufficient to add a minute quantity to the finest white crystals to make them assume the appearance of sugars below No. 7. You will further see that by using more or less heat in the pan in which sugar is boiled, deeper or lighter tints of colour may be obtained with the same degrees of saccharine strength. The means used to modify the colour of sugars are as ingenious as they are varied; and though some would fall directly under the notice of the officers, there are others, like the last I have mentioned, which defy all means of repression. It does not follow that the department should not take steps against abuses which have for some time become a public scandal. I direct, therefore, in the most urgent manner, that all attempts at colouring which the law can reach shall be brought to the knowledge of the authorities whenever the officers have the opportunity. I request, also, that the classification of sugars leaving factories shall be attended to with the greatest care. At the point to which things have come, classification according to colour is almost useless (*n'offre plus que de très faibles garanties*). Officers, therefore, must not confine themselves to comparing the colour of sugars with the standards; they must base their classification not only on the syrups from which sugars have been made, whether of the first, second, or third boiling, but also on the method of manufacture and the size of the crystals. In case the classification is disputed by those interested, officers must not hesitate, when sugars appear to have a strength higher than their colour, to take samples in order that they may be examined by experts. In a word, nothing must be neglected to defeat frauds which so seriously affect our receipts. In forwarding these instructions to the officers under you, you cannot too strongly insist on this point."

The *British Trade Journal*, in which the foregoing translation is given, adverts to the circumstance that the "poisonous sulphocyanide of iron is known to be applied sometimes to the use indicated, but curiously enough is not mentioned in the list of colouring agents cited by M. Provensal."

## PRODUCTION OF GLUCOSE IN ANIMALS.

Saccharine matter, long thought to be exclusively a vegetable product, has more recently been found as a normal constituent in the animal economy. The mode of its production has attracted much study of late years; and it is to the labours of M. Claude Bernard, we are chiefly indebted for our knowledge of the subject.

Sugar is found in nature in a great variety of forms. Of these, the most important are the *glucoses,* comprising *dextrose* or grape sugar, *levulose,* found in honey and certain acid fruits, *galactose,* a product of reaction with others, and the *saccharoses,* comprising the *saccharose* from sugar-cane, *melitose* from Australian manna, an exudation of Eucalyptus, *meleritose* from the *Pinus larix, lactose,* &c.

From the physiological point of view, there is a striking distinction between glucose and saccharose. In plants, grape sugar acts as a reparative, whereas cane sugar, entering into the nutritive movements, becomes merely an excreted product. It can only serve for nutrition for the growth of the plant where it has been previously changed into glucose.

This fundamental difference also appears in the case of animals. If a solution of cane sugar be injected into the veins, the substance will be eliminated entirely by the urine, without having any nutritive action. If even five centigrammes of cane sugar be injected into the jugular vein of a dog or a rabbit, it will be detected in the urine; whereas the gramme of glucose may be injected, and no trace of it be found in the urine. M. Bernard injected a mixture containing the two kinds of sugar in equal quantity; the glucose was appropriated by the system, and the cane sugar isolated, appeared in the urine. These two substances are, then, radically distinct, from a physiological point of view.

It is necessary to remark, however, that cane sugar, introduced into the digestive system, is changed into glucose, and thus becomes fit for nutrition. In plants a similar change takes place. Cane sugar can be converted into glucose by a number of chemical agents, and even through mechanical action, such as pulverisation. In household use, ground sugar has a less sweetening effect than sugar in pieces; and the reason is, that part of it has passed (through bruising) into the state of glucose.

M. Bernard has described various processes for separating the sugar in animal tissues and liquids. The most exact method consists in treating with alcohol,—boiling the tissue or liquid in water, coagulating thus the albuminoid matter, and then filtering. Or the animal liquids (such as blood and urine) may be heated after addition of animal carbon; the colouring matters, the salts, and the uric acid are retained by the carbon, and the albuminoid matters are precipitated. Then by filtering and washing, the saccharine liquor is obtained. Animal carbon is, according to M. Bernard, an excellent means of discovering the least traces of sugar in the urine and the intestinal liquids. Sulphate of soda or acetate of lead may be used for precipitating the albuminoid matter In order to recognise sugar in the filtered liquor, recourse is had to fermentation, to potash, to salts of bismuth, and salts of copper. These processes are well known. The surest method is that of fermentation.

The labours of M. Bernard and other observers have established—

1st. That glucose exists normally in the blood.

2nd. That the presence of this substance is independent of animal or vegetable alimentation.

If a dog that has been fed with meat ten days be bled to death, and the blood examined by any of the methods which have been referred to, the presence of glucose in the filtered liquor may be readily perceived. But in the case of diseased animals, glucose is entirely wanting, even though they have continued to eat. In the experiment with the healthy animal the sugar has not come from without, for the food did not contain it.

When the blood has received a certain amount, it eliminates the surplus supply by the kidneys, as it does with other alimentary principles. When a great deal of sugar is given to an animal, it does not, in consequence, accumulate more largely in the blood; when no sugar is given, the sugar does not, in consequence, disappear from the blood, but continues to be produced. The presence of sugar in the blood, in a proportion which is nearly constant, is thus ascertained to be independent of alimentation.

As there is always glucose in the blood plasma, we might expect to find it in all the organs; but hitherto analysis has failed to detect its presence in tissues deprived of blood. There is only one organ which forms an exception: the liver. This contains considerable quantities of sugar, and it is here, according to M. Bernard, that sugar is produced. He maintains that the sugar is not furnished with vegetables; because it is met with in the livers of dogs which have been fed on meat for more than a year. He proves also that the blood entering the liver contains no sugar, while that which issues is charged with it.

Lehmann and others supposed that the sugar was produced in the blood, through decomposition of albuminoid matter. But the process is one which may take place quite independently of life. There is, in the system, and more especially in the liver, a substance similar to starch, named *glycogen*, which is transformed into glucose by a ferment like diastase.

As regards chemical composition, there is no difference, M. Bernard says, between the starch of plants and glycogenic matter. This is demonstrated by analysis. In its susceptibility of being changed to sugar, glycogen also resembles starch.

Glycogen, whether in the granulated state, as a white mealy powder, or in solution with water, is capable of being coloured by iodine; but the iodide of glycogen is never so blue as the iodide of starch; its colour varies generally from a vinous red to rose. Like starch, glycogen gives a dark cross with polarised light. But many other substances produce the same effects.

To recognise the presence of glycogen, M. Bernard advises recourse to be had always to chemical characters, and to the transformation of the substance into dextrine and sugar. The observation of M. Dareste, in which, examining hen's eggs with a microscope, and perceiving the dark cross in polarised light, he inferred that they contained starch, was insufficient. According to M. Bernard, eggs not brooded on contain no starch, and glucose is found only in the white of the egg, not in the yellow. The amylaceous substances which M. Dareste found in the egg, do not appear to have had the micro-chemical characters of starch, for they disappeared on addition of water, of alcohol, or of ether. M. Balbiani asserts that the granules of glycogen do not present the polarisation properties of vegetable starch in animals of warm blood, and that in insects they do. Further experiment, however, is apparently required for the elucidation of this delicate subject.—*English Mechanic and World of Science.*

## CONTRIBUTIONS TO THE AGRICULTURAL CHEMISTRY OF THE CANE.

By Dr. T. L. Phipson, F.C.S.,
*Foreign Member of the Chemical Society of Paris, &c.*

Now that the chemical constitution and physical properties of some of the principal cultivated soils in Demerara, Barbados, Trinidad, &c. are no longer a secret to me, now that I have positive assurance of the success which has attended the cane manure which I particularly devised for these soils, and which I made known in former pages of this magazine, under the name of Urban Cane Manure,* I have more confidence in stating my opinion with regard to the agricultural chemistry of the cane, and in endeavouring to fix the value of certain propositions entertained by other writers.

Those who have glanced through my former papers on Cane Soils and Cane Manure, in this journal, will have seen that there are three special agricultural difficulties in the direct path of the cane grower in the West Indies. The first is that he is dealing almost everywhere with a stiff clay soil, difficult to work even were labour more plentiful than it is; the second is a notable falling off, or weakness, in the amount of lime present in the soil of many districts, whilst it is sufficient for a considerable number of years in some others; and the third is the imperfect nature of the manures hitherto imported, and the implicit faith placed in the restoration of the megass ashes.

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* *Vide* The *Sugar Cane* for August, 1871, and March, 1872.

The experiments of Way and Liebig upon the absorptive powers of soils are not only exceedingly curious, but place before us in the strongest light the great importance which attaches to the physical condition of almost any variety of soil. They found, it will be remembered, that potash, ammonia, soda, phosphoric acid, in fact, all those substances which modern chemistry has shown to be necessary to the life of the plant, were extracted by the soil from the liquid which oozes through it, and retained for the want of the crops. This fact, which appears to be thoroughly well established (since it was *discovered* by Baron Von Liebig many years after Professor Way had discovered it, and afterwards most honourably acknowledged by him as Way's discovery), led my much lamented and talented friend Professor Nicklès, of Nancy, to suppose that the soil represented in this respect the stomach of the plant, and that the process of *digestion,* as regards the vegetable kingdom takes place, at least to a certain extent, in the soil. "In natural history," said this eminent chemist, "plants are distinguished from animals by the absence of a digestive tube, whilst both feed and grow equally well," and then he asks,—may not this peculiar property of a fertile soil correspond to the functions of the digestive tube in animals? *

Perhaps we have here a key to the great secret as to what constitutes a fertile soil. Why is a soil which is devoid of certain chemical substances sterile? Why is a soil which has all these ingredients present fertile? Is it not connected in some way or other with the absorptive or digestive phenomenon alluded to above? But when the soil is a stiff clay, and difficult to render porous, it follows that this digestive process is also difficult, since the liquids cannot ooze through these compact masses and distribute the nourishment they contain.

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* *Le Congrès Scientifique de Carlsruhe,* Nancy, 1859.

Lime and sand spread over the surface of these soils at various intervals, like the process which we call in England "top-dressing," both ingredients being in the state of a coarse powder (and not in lumps nearly the size of potatoes, as has been the case in some Barbados soils, where the said lumps, slightly diminished in size, are still to be seen sticking in the clay, though the application was made about eight years ago), will be carried down into the soil during the rainy season and greatly improve its quality. I have very little doubt that if this application were systematically adhered to, and each top-dressing of lime, marl or chalk, alternated with a similar top-dressing of Urban cane manure at about two months interval, it would be possible to double the present yield of canes on almost any of the Demerara soils within the space of four or five seasons. Moreover, such a treatment, without further trouble, would increase the fertility of the soil year by year, so that instead of becoming exhausted by cane culture, it would be fit, after a long lapse of years, to grow any other crops that might be placed upon it, and would undoubtedly grow fine crops of canes for many generations. This would be to some extent a *chemical* process for inducing porosity and the elements of fertility in a soil, the nature of which renders the *mechanical* action of the spade or the plough so difficult and so expensive.

Such is the treatment I shall certainly apply to my own cane fields, when I may be fortunate enough to possess any, and that which, in the meantime, I have urged upon members of my family who are directly interested in this matter, and will one day thank me for it.

It is fortunate for sugar planters whose crops are raised in the heavy clays, of which I have been speaking, that the roots of the cane extend to so short a distance downwards, which fact enables us to apply manures broad cast on the surface, and trust to the rain to carry them within reach of the roots, in a comparatively short space of time. But for this purpose, of course, the manure must not be of a kind that will remain upon the ground in spite of the rain; nor again, must it be so soluble and acid, that on arriving at the roots, in a soil deficient in lime, it will only injure the young plant. There is fortunately a happy medium in which, as old writers told us, the truth exists.

I cannot help feeling some surprise that there should exist writers who, in spite of reason and renewed experience, still recommend superphosphates and sulphate of ammonia for the cane; even if they have never trodden the soils of the West Indies, they might have convinced themselves at home of the comparative uselessness of this mixture on wheat soils. "Manufactured manures," says a writer in the last number of the *Quarterly Review*, "are not perfect restoratives, and land treated with them alone generally fails in a few years to yield a heavy crop." To have stated the whole truth, this writer would have done well to have said, "manures hitherto manufactured." To believe that agricultural chemistry will stop at superphosphate or phosphoguano as the *ne plus ultra* of this manufacture, is to have little notion of the resources of the laboratory and to ignore the results of recent efforts; and to value all manures by the amount of acid, or soluble, phosphate and nitrogen they contain, is to compress our ideas into very narrow limits.* In this top-dressing system, above mentioned, which will, I am convinced, prove invaluable in Demerara and Barbados, even in the worst of seasons, I would by no means urge a continuous use of Urban cane manure alone for a series of years, but would alternate it, at short intervals, with moderate doses of Peruvian guano, and of compost heap,† farmyard, or pen manure. There can be little doubt that all plants, like animals, require a change of diet at intervals, and are very much the better for it. Let us not be deceived either in the due appreciation of the influence of season when testing experimentally the results of any particular course of culture, soils which have been purposely exhausted, have been known to yield considerable crops of wheat in extraordinarily fine seasons, without the aid of any manure, which soils in ordinary circumstances required high manuring to yield a crop worthy of the name. The height and thickness of the canes are in direct ratio to the natural fertility of the soil and the efficiency of the manure used; the more they are exposed to the sun, the richer they are in sugar. Abundance of rain reduces their yield far more than a prolonged draught, so that of the two evils, the latter is to be preferred. In new ground it is prudent to leave more space betweed the canes than in soils worked for some years, for in the former case the leaf vegetation is more active, and if too closely planted the circulation of sunlight and air is impeded. Generally speaking, canes in heavy clay should be cut a little later than those in lighter soils.

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* A more complete system of valuation has recently been set forth in the pages of the *Sugar Cane*, by Mr. Reynolds, of the Royal Society of Dublin, but it does not differ materially from that originally proposed many years ago, by the late Mr. John Nesbit, and no figure is quoted for precipitated phosphate of lime, such as that in Peruvian guano and Urban manure.

† On the manner of constructing a compost heap near cane plantations, see my paper *Practical Observations on Cane Manure*, No. VI in the *Sugar Cane* for November, 1870.

Besides the remarkable experiments of Prof. Polstorff, alluded to in my former papers, and the testimony of Liebig, Dumas, Boussingault, and others, upon the efficacy of excremential matters when compared with other kinds of manure, I should allude also to a series of experiments by Jaquemart, published in the *Comptes rendus* of the Academy of Sciences at Paris, in 1852: He compared the action of *pure salts of ammonia* with that of a manure made from excreta, like the Urban cane manure, but containing only 2 *per cent.* of ammonia, a fine crop was raised with the latter, and it was found that 2 per cent. of ammonia in this kind of manure was equal in its effects to 100 *per cent.* in the pure ammonia salts, such as sulphate and carbonate of ammonia.

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# THE SANDWICH ISLANDS, THE FUTURE SUGAR COUNTRY OF THE UNITED STATES IN THE PACIFIC.

The question has frequently come up for consideration, both in and out of Congress, whether we should not strive to become as much as possible, materially independent of all other commonwealths. Much national pride attaches to the idea, and, with the exception of certain metals, and coffee, sugar and tea, we are at the present day materially independent of the rest of the world. We might, on an emergency, dispense for a couple of years, while engaged in a war, even with coffee and tea, but we could not well do without the importation of sugar, tin, and spelter.

Cuba, the most important country to us, as the source from whence we draw the bulk of our sugar supply, we may eventually become the owners of, in somewhat the same manner as Louisiana and Florida were acquired, by either cession or purchase. To wage a war for the acquisition of the Island, would evidently not pay, since the financial disturbance in our midst would endanger interests too mighty to be trifled with.

But the continued dependence upon Cuba for sugar may be to some extent circumvented, either by our acquiring St. Domingo, and reinstating sugar culture there, as it stood under Spanish and French sway, adding to it the cultivation of coffee on an extensive scale, or we may become the owners of the Sandwich Islands and convert them into a second Barbadoes, covered with sugar plantations.

The acquisition of St. Domingo would have become a positive fact by this time, if the plans of President Grant had not been for political purposes, assailed by Sumner and Schurz and rendered unpopular by newspaper agitation. We shall consequently not now consider this plan of obtaining a sugar and coffee colony at our very doors, although it be not altogether abandoned.

As a less unpopular substitute for St. Domingo, we have the idea suggested to the nation of acquiring in one way or another the Sandwich Islands, a most convenient mid-ocean half-way station on the path to China and Japan.

Their possession would give us a sugar-producing country of the first-class, right off; and should we be able to procure the amount of manual labour we need for the purpose, not many years would pass, until from 50,000 hogsheads of sugar, we should raise the production to four times as much.

Hawaii, the main island, occupies 4,500 square miles of the 7,500 constituting the area of the whole group. Jamaica has an area of 5,500 square miles.

In a couple of years we should produce as much sugar in the ten islands as Jamaica has done in her palmiest days, and our Pacific States would be altogether independent of Java and Manilla for all time to come, so far as our main staple of imports were concerned.

Another important consideration would be the opportunity we should have of practically solving the question of desirableness of acquiring islands confronting our coast, whether it be on the Atlantic or Pacific shore.

Were the peaceful possession of the Sandwich Islands to prove a national boon, that of St. Domingo would be better appreciated should we think less unfavourably of it in the meantime. As it is, the Polynesian group, called the Sandwich Islands, ships all its sugar to San Francisco already, and from the moment the flag of the Union waved over them, the advantage of coming in duty free, would render sugar culture so profitable there, that planters would remove to Hawaii from all quarters, from the United States, from Java and Manilla. None of the drawbacks of night frosts experienced in Louisiana, would hinder cane cultivation there, and there would be no country like Cuba, as in the case of Louisiana, to compete with slave labour, near at hand, against the free labour of Hawaii, for Java and Manilla are distant from the Pacific States. That the Sandwich Islands will eventually become American, little doubt can be entertained. The question has arisen whether it shall be now, or whether English influence shall prevail and a mock throne be again raised there, a laughing-stock to all nations, because deprived of all dignity.—*American Grocer.*

## THE "GREENOCK SUGAR TRADE REVIEW."

The prospectus of this publication, recently circulated, promised that the object aimed at would be "to promote the extension and prosperity of the sugar trade, both raw and refined, and to endeavour to remove any obstacles that may be found to stand in the way of the further development of this highly important branch of commerce." The *Review* will have a large field for usefulness, and will find ample scope for all the energy and vigour with which it may be endowed.

We hailed with considerable interest the advent of the first number on the 3rd ult.

The colossal character of the sugar refining trade of Greenock, and the rapidity of its extension, are therein set forth, and a lurking fear is betrayed lest sufficient mouths cannot be found either in the old world or the new, to dispose of the increasing products of the refineries of Scotland.

That this fear is by no means groundless is to be inferred from the following figures:—

Sugar Refined in Greenock.

| | |
|---|---|
| 1842-3 | 11,543 tons. |
| 1852 | 41,664 ,, |
| 1862 | 106,748 ,, |
| 1872 | 208,870 ,, |

"This remarkable result" we read "has been obtained, not only by the exercise of great energy and enterprize, but *in the quiet and unobtrusive* manner which has ever been distinctive of the Scottish character." Sidney Smith denied to our northern neighbours the possession of any sense of the humorous; if that great wit be correct, the editor of the *Review* is not a Scotchman. The 700 or 800 lines of matter in the first number, furnish many examples of this *quiet and unobtrusive manner.* Thus we are assured that "no real grievance will be treated with indifference, or any inequality or abuse permitted quietly to remain." To show that they are as good as their word, the Scottish refiners take in hand the important subject of the out turn of floating cargoes of sugar, and draw up a series of resolutions intended to keep the vendors up to the mark, and requiring them to make good any difference exceeding sixpence per hundredweight, between shipping sample, and bulk. We do not dispute the need of dealing with the abuses that have injured the fair trader, no less than the buyer under the old system, but simply draw attention to the "quiet and unobtrusive manner" which is a characteristic of the Scotch. The merchant may plead that some sugars deteriorate on the voyage, and it would be hard to gainsay the fact; yet it is just that the buyer shall not bear the loss of this deterioration, but if he buys by sample the bulk must match it, or the difference be allowed. The retiring Scotchman treats the subject in another way, he says,—"There is no necessity, whatever may be asserted to the contrary, for a cargo of sugar to fall off during the voyage so as to become inferior on landing to a fair sample taken at shipping."

The rates of carriage of Scotch sugars into the Midland counties of England are so low, that English refiners are almost beaten off from their own ground. They will therefore appreciate the "quietness" that dictates the following sentence which heads a leading article, "It is noticeable that Greenock sugars labour under serious and in many cases unfair disadvantages in the matter of rates of carriage, and freight."

One further example of the "quiet unobtrusive manner" of the Scotch may suffice. In an interesting article on the subject of the export of "crushed," it is shown that in 1866, Scotland did not secure two per cent. of the small British export trade of 10,000 tons of sugar, but it took a larger share during each succeeding year, until in 1872, fifty per cent. of all exported sugar left the Scotch ports, and as the export trade has grown rapidly in the seven years, the absolute amount exported by the Scotch refiners has increased nearly one hundred fold. In that article appears the following remarkable passage: "Our home fields are tolerably well cultivated, and the fact that we are adding to our power of production more rapidly than we can reasonably expect the consumption of the country to increase, leads us to the conclusion, that for any further material development of our local industry, we must either look to an export business, or to our being able to drive our English competitors out of the trade."

If this be "quietness" and "unobtrusiveness," what may be expected when the refiners of Greenock think fit to adopt an active and aggressive method of conducting their business?

We gladly welcome the *Greenock Sugar Trade Review*. It will fill a useful place, and will also serve as an antidote to another *Review*, the main purpose of which appears to be, to attack the refiners of Great Britain, and to write down the value of their productions. Contrast the following:—

| *Greenock Review*, Feb. 3, 1873. | *Produce Markets Review*, Feb. 8, 1873. |
|---|---|
| "The opinion is general here, that so far as crushed is concerned, prices are not likely to be lower for some time to come." | "Everything points to cheaper instead of to dearer sugar, and to suggest great caution in buying pieces," &c. |

If the object of the sugar refiners of Scotland be to make crushed sugar, their policy should be to increase the number and capacity of the refineries, as in fact they have already done. If, however, they should have a different object in view, namely, that of making money, they would do well to limit their production, and remember that the pleasing process of driving their English competitors out of the market, may be accompanied by the inconvenience of destroying their own trade in the struggle for existence. They may take a lesson from the colliers, as to the effect which a limited supply produces upon prices.

The *Greenock Sugar Trade Review* will be a welcome addition to the scant literature of the sugar trade, and we doubt not that merchants, brokers, and grocers will be sure to make good use of it.

# SUGAR CULTURE AND POLYNESIAN LABOUR IN QUEENSLAND.

The atrocities that have been perpetrated in connexion with the immigration of Polynesians into Queensland, have roused the attention, not only of the colonists, but of the Imperial Legislature, which has passed an Act for controlling this traffic. On the 10th ult., the attention of the House of Lords was again directed to the Polynesian expedition, by the Earl of Belmore.

The history and origin of the employment of the islanders in Queensland, and the degree of dependence of sugar culture in that colony upon imported Polynesian labour, is ably treated in a written communication from a gentleman of experience in the colony. The following is mainly extracted from this document:—

The lessees of the waste lands of the colony, it would appear, were the first to desire the employment of coloured labour in Queensland. The system on which waste lands are leased is an injurious monopoly. The lessees have been opposed to free, abundant European immigration, for the more people from Europe came, the less secure would the tenure of the land leases be. On the other hand, they approved of convict immigration, as colonists of this class necessarily constituted a servile community, who would not be likely to compete with them in the occupation of land. Thus, the squatters regretted exceedingly the discontinuance of transportation to Australia. The experiment of Coolie labour was tried, but without the smallest success. The Indian Coolies were of no use, from their indolent character; the Chinese Coolies could not be employed continuously, and went each one in his own way independently, in a very short time, and then they insisted upon first-class wages, whereas the squatters from the habit of employing convicts have always been inclined to parsimony in the matter of wages. Meanwhile European immigrants continued to arrive, though slowly, and they persistently demanded land. They did not desire that the squatters should be wholly dispossessed of their leases. They said that it was unreasonable that one man should have a piece of land as great as Lancashire, and not make any use of half of it, and that another man should be pleading in vain for a piece of 40 or 100 acres of it for cultivation. Whilst this controversy was proceeding, the war in America broke out, and cotton rose to a high price. Cotton had been grown as a garden plant in Queensland for years, now the time had come it was thought to try its cultivation on a larger scale. An enterprising Sydney merchant obtained a free grant of 1,280 acres, and sent for Polynesians to cultivate them. The experiment did not ultimately prove successful, and this very plantation has been abandoned to the opossums and bandicoots for the last five or six years. Had European labour been employed, whether the cotton scheme had answered or not, the probability is that the land would have remained in cultivation, for the Europeans would have built houses and settled there.

Polynesians have continued to be imported in greater or fewer numbers; let us then see how far this class of labour has proved profitable up to the present time. With September, 1872, a severe winter ended, and spring was only just shewing. In July, there were continual frosts; not such frosts as are common in England, but ice thicker than a penny piece where water had been out of doors in buckets. The effect of this frost upon the grass is to turn it to a dull brown. Cotton stands such frost pretty well. Sugar is much more sensitive. All around Brisbane the sugar canes have suffered; in the low-lying places, all but killed. Last year, a sugar farmer, living 30 miles from Brisbane, calculated upon 80 acres of cane to grind: the frost reduced his quantity to less than half. This year he ground frosted canes, got to work early, and though the returns are small, yet he is better satisfied than he expected. His work has always been done mainly by Europeans, he was obliged to take over some six Polynesians when he bought the place. Near to him was another sugar plantation, upon which Polynesian labour has had more than a fair trial. The pecuniary results have been yearly worse, and at the present time the estate is abandoned. Owners of plantations and sugar companies, who had hoped for brilliant results from Polynesian labourers, are now finding that their hopes are not likely to be realized, but it would be unfair to attribute want of success to this element alone.

It would seem, however, that to another class of colonists, the want of success achieved by the large capitalist when employing Polynesian labour, is not unwelcome. They, say that were it otherwise, they see no prospect for the man of small means who knows how to till land himself, can employ little hired labour, and who has nothing to learn of practical work from his hired labourers, and also knows no way of making money but by hard work and saving. There are many such round Brisbane growing sugar, and greatly satisfied with the results of their industry. These are they (says our correspondent) who alone can grow sugar profitably, and each year sees their numbers increase. They have from the first distrusted the wisdom of employing coloured labour, and not having the money to give, (£10 or £12 a head for Polynesians of whose value as labourers, they could not but be suspicious) have made do without, and they have prospered without. The experience of the small farmers, with their ten, fifteen, or twenty acres of cane, clearly proves the untruthfulness of the allegations against the climate as being too hot for Europeans to do fair work. Before cotton or sugar were thought of, this class of farmers grew English potatoes, maize, and other things. The cultivation of maize is fully as arduous as that of sugar, yet no complaints were ever heard from them of the heat. Looking at the subject in every way, the demand for Polynesians or coloured labour was always confined to, and is at present limited to, the handful of people who want to live by the labours of others rather than their own, and is not sympathized with by nineteen out of twenty practical real farmers.

At the commencement, the Polynesian traffic was expected to prove very profitable; experience has found it to be the reverse; and it is asserted that all who have tried, have lost by coloured labour, and will probably cease to make further essays, and, indeed, would desist, even if Polynesians could be imported with as much impunity as was the case before the passage of the Pacific Islanders' Bill.

The main argument against coloured labour in Queensland has never been shaken. It is that Queensland was not established with a view to such labour, and that the introduction of it is in absolute, direct and irreconcileable variance with the social condition of its colonists, with the political institutions which exist in active working, and with the genius and spirit of the colony. Such a state of society as is found in British Guiana or in the Mauritius, is simply impossible in Queensland. The colony recognises perfect equality of everybody before the law, and would resent the enactment of special laws to meet the requirements of coloured labourers. When the Polynesian Labourers' Act was in committee in the Colonial Legislature, a clause was struck out which visited with penalties any person or persons "harbouring" Polynesians who absent themselves from the service of their owners. The clause was in the first draft, and its retention was advocated by the would-be employers of Polynesians, but the House dare not but excise it.

There has been some talk of employers arranging for being supplied with Coolies from the Mauritius. If it be true that Coolies are attended with cash expenses from the beginning, and straight on to the end, the sugar growers will soon be sick of them. And then it will be with them as with Polynesians, they can always run away and nobody will blame them or help their masters to fetch them back. The police will not bother about them, and public opinion will be strongly and unchangeably against the masters, so that the hope of cheap reliable labour from Coolies will be disappointed.

Though an honest desire on the part of the higher Government officials in Queensland to put down this form of slavery may scarcely be expected, the time is approaching when the continuance of the system even in a modified form will be impossible. The colony is becoming so honey combed with mines and miners that the difficulties in the way of establishing coloured labour may be said to increase daily. The dispersion of the diggers and miners everywhere tends to prevent the formation of little colonies of employers of coloured labour, so that Queensland will ultimately clear herself, and stand cleared before the British public from the stain. And if true unexaggerated accounts of the climate, the soil, and the possible productions, were placed before the public, it would be seen that it would be a British calamity to allow such a noble colony to be closed against our fellow countrymen.

## MEETING OF SUGAR REFINERS OF NEW YORK.

Some time since the sugar refiners of this city and its immediate vicinity formed themselves into a "Sugar Refiners' Association," for the purpose of forwarding the interests of their branch of trade. About thirty members now belong to it, representing an aggregate of 12,000,000 or 15,000,000 dols. A meeting was held on Tuesday, at the rooms of the Importers' and Grocers' Board of Trade. The Committee on Trade Statistics reported that the depressed condition of the business proceeded from a surplus production. The Committee asked for a recommittal of the subject. From what occurred, it was admitted that the present capacity of the refiners enabled them in ten months to manufacture all the material that was consumed in twelve. The remedy is to be considered at the next meeting.—*American Grocer*.

## PURCHASE OF CANES BY WEIGHT.

We are new to our business as growers of cane and makers of SUGAR. Every year adds considerably to our experience, and we do well to treasure up and apply the facts added to the store. There is so much importance in the observations of Dr. Neild, a practical sugar-grower at Port Macquarie, that we give them as much prominence as possible. It tends to the growth of the best sorts of cane and cutting the same under the most profitable condition. If his suggestions are carried out, it will not lead to the growers getting more, but to the country getting more.

"Some time back you favoured me by inserting a few lines in which the relation between the worth of cane and the principle of estimating it commercially were glanced at in general terms. Through the same medium—your widely circulated columns—allow me to call the attention of growers and intending purchasers of cane to a more particular examination of this most important point, by subjoining a few calculations which go far, in my opinion, to explain the disappointing results to some mill-owners of buying and manufacturing at one stated price per ton. I do not hesitate to add, that unless the simple common sense rule of paying for an article what it is worth, and not a merely theoretical or fancy price, be applied to sugar cane, but little satisfaction and less profit can be had in dealing with it and for it. The price of ten shillings per ton for all sorts and qualities of cane indiscriminately, is not less absurd, than disastrous to those who give it; and it is, moreover, a direct premium on bad farming and neglect.

"But to pass from assertion to demonstration, let us work out the question, and see how it operates in (say) 40 tons of sugar.

"First, let us note the per centage of sugar at four different densities, Beaumè, viz., at

| | | | |
|---|---|---|---|
| 7° | ·124, | or | 12 per cent. |
| 8° | ·144, | ,, | 14 ,, |
| 9° | ·163, | ,, | 16 ,, |
| 10° | ·182, | ,, | 18 ,, |

"Surely these figures are significant enough.

"But let us go to the actual *purchase* of the cane and its *conveyance* to the mill, and the cost of *fuel* for its conversion into sugar; the cost of labour for the processes in the manufactory I do not touch upon, and it would not, if discussed, at all weaken my argument.

"I assume, then, that at

| | | | | |
|---|---|---|---|---|
| 10° | Beaumè, | 12 | tons of cane give one ton sugar | |
| 9° | ,, | 13¼ | ,, | ditto. |
| 8° | ,, | 15 | ,, | ditto. |
| 7° | ,, | 17 | ,, | ditto. |

But instead of working out our problem at 10s. per ton, let us take as our unit the rate of 1s. per degree. This may be deemed a large concession to the mill-owner; but it does not save him from serious loss and disadvantage. I have calculated the cost of the cane, at 1s. per degree, and charged for cutting, punting, loading, and unloading, at one uniform rate per ton, and fuel in proportion to the number of tons of cane to the ton of sugar. And this is the outcome; the prices for each stage need not be specified.

Sugar, so far as cutting, punts, and loading, and fuel are concerned:—

| | | | | | |
|---|---|---|---|---|---|
| From cane at | 10° | Beaumè | costs | £12 4s. 4d. | per ton. |
| Ditto ,, | 9° | ,, | | 12 16s. 8d. | ,, |
| Ditto ,, | 8° | ,, | | 13 17s. 6d. | ,, |
| Ditto ,, | 7° | ,, | | 14 14s. 0d. | ,, |

In other words, 40 tons of sugar made from cane at 10° Beaumè costs, £100 *less* than 40 tons made from cane at 7° Beaumè, the cane in each case being paid for at the same rate of 1s. per ton per degree. Surely the advocates for buying 'green stuff' at 10s. per ton will pause in the face of these facts."—*Sydney Mail.*

## WEST INDIA & PANAMA TELEGRAPHIC COMPANY.

A movement, initiated by the leading shareholders, is on foot, to complete the lines of the West India and Panama Telegraph Company, which, owing to the litigation with the contractors, have not yet been carried to the mainland. The Company has a good business between the West India Islands, but feel the want of communication with the mainland. It is suggested that a meeting should be called at once, to devise some plan, either in concert with or independently of the present directors. The Company is entitled to important subsidies, which would at once yield a revenue, and negotiations are pending with the Atlantic Companies which will lead to working arrangements with the West India Company, on the completion of its system.

# ON THE INFLUENCE OF FORESTS ON RAINFALL.

BY ALFRED FRYER.

(Continued from page 89.)

Some quotations have already been given from the writings of *M. Becquerel;* the following are translated extracts from his book "On Climates, and the influence which they exert upon wooded land and on bare land":—

> "It has long been observed that the clearing or cutting down of the woods dries up or diminishes the sources [of water], and also exercises in a more or less marked degree, an influence on the quantity of fresh water which flows through a country.
>
> "*De Saussure* has already noted the diminution of the water in the lakes of Switzerland, which followed the clearing of the forests, chiefly in the lakes of Morat, of Neuchâtel, and of Bienne.
>
> "*Choseul-Gouffier* has not been able to retrace the river Scamander, which was still navigable in the time of Pliny; its bed is now entirely dry; but the cedars which covered Mount Ida, where was its source, no longer exist.
>
> "*M. Boussingault*, during his residence in Bolivia, studied this question; he took for the base of his observations, the lakes which were situated on the plains or on the various steppes of the mountains, which might be considered as natural gauges, intended as means to estimate on a large scale the variations resulting from the quantity of water which falls upon a country."

After recounting various examples of the denudation of forest being followed by a diminution of rain, or a lowering in the water level of lakes in the neighbourhood, he concludes that the destruction of forest is the true cause of such diminution of rain, and strengthens his position by the assertion that—

> "Other lakes, such as that of Tota, not far from Fuguéne, situated in localities where there had been no forest clearing, had not shown any falling off in their waters.
>
> "It may be easily conceived that a soil covered with trees is less favourable to evaporation than land which has been cleared. Who has not, in fact, remarked in travelling a road which traversed alternately a cleared and a wooded country after a period of rain, that the wooded part is still covered with mud whilst the other is quite dry.

"But must this diminution of running water, in consequence of disforesting, be attributed to a less quantity of rain, to a greater evaporation, or to a new distribution or division of the rain water?

"*M. Berghans* has urged that the volume of the waters of the Oder and the Elbe decreased from 1778 to 1835 for the first of these rivers, and since 1828 to 1836 for the second. This diminution is so palpable, that if it always follows the same law it will become needful to change the form of the boats; some statistical researches have proved that these facts cannot be attributed to the clearing of the forests on the mountains.

"The explanation has been sought in the enquiry, whether the quantity of rain fallen in Europe has not diminished, but without any further satisfaction. In fact, since 1689, the rainfall in Paris has been observed, and a slight increase rather than a diminution has been observed. *Césaris* has certified a similar increase in the city of Milan since 1763 up to this period. It is the same at Rochelle and in the valley of the Rhone.

"The hypothesis of the diminution in the rainfall being rejected, it has been supposed that perhaps the number of days of rain might have changed, founding it on the generally admitted fact, that great rains supply more water to the rivers than the same quantity of water falling in many days separated by intervals of dryness.

"But the discussion of these observations has not further cleared this question; it has been needful to consider the change in climates which has been brought about by culture.

"In considering as a whole the observations previously reported, we are led to the following conclusions:—

"1st. Great clearances [of forest] diminish the quantity of water which circulates in a country.

"2nd. We cannot yet decide whether this diminution should be attributed to a smaller annual rainfall, or to a greater evaporation of the rain water, to the two effects combined, or to a new division or distribution of the fallen rain. At the same time, we will remark, according to *M. Boussingault*, the observations made in the equinoxial regions favour the hypothesis that great clearance of forests diminish the annual rainfall.

"3rd. In those countries which have not hitherto experienced any change in culture, the amount of water does not seem to have changed.

"4th. Forests preserving the running waters regulate their flow.

"5th. Culture established in dry and bare countries diverts part of the running waters.

"6th. Springs may disappear in consequence of the local clearances [of forests or woods], without our being able to conclude that the annual rainfall had diminished."

At the last meeting of the British Association, *M. Lemaine* read a paper, wherein he considered the influence of forest upon the amount of rainfall in the valley of the Seine as doubtful. That there the substitution of grass or other permanent cultivation for forest did not affect the water courses.

"Forests however prevent the earth being carried away; it follows that, in mountainous countries, they retard the flow of torrent waters. In fact, in the Hautes Alpes, the presence of forests prevents the formation of torrents; the replanting of woods extinguishes torrents already existing; but in most cases turfing alone is sufficient to produce the same effect. These conclusions must be carefully limited to the countries in which they have been obtained. Mr. Brown said there were indications that a great portion of South Africa had been under water, but at what period had not been ascertained. The trees varied in magnitude in different quarters, and yet were of the same magnitude in each locality. The desiccation of the country has been going on since the draining off of the waters, owing to evaporation. The destruction of herbage and grass by fire, the use of the axe by native and colonist, and the formation of sheepwalks, facilitated the process of evaporation. Mr. Blore sunk two cylindrical jars of the same size, in the ground to the depth of 4in., leaving them projecting 1in. above the surface. One was placed where it was practically protected; the other was sunk in a newly cleared plot. Into each jar was put 20ozs. of water on January 31st. On February 5th the water remaining in each was carefully measured, and it was found that the evaporation from the jar in the open ground had been more than double that from the other jar, which was partially protected, though not covered by bush.

"The circumstance of the removal of forest in the centre of France, not being followed by diminished water supply, may possibly be due to the class of wood of which the forests were composed, for 'it is now pretty well known,' the *Athenæum* states, 'that woods and forests of leafy trees promote rainfall, and nourish the flow of springs and rivers; but it is not so well known that trees of the kind described by the Germans as *Nadelholz*—needle-wood—produce the contrary effect. That such is the fact, however, appears from a statement which will be read with interest by owners of waste lands. The forest of St. Amand, situated in the north of the district of Valenciennes, comprising 1,800 acres of silicious sand mixed with a small quantity of clay, was formerly covered with scrub, and stunted clumps of oak and birch, and being in places very damp, was much haunted by snipes. In 1843, this unproductive growth was cleared off, and Scotch firs *(Pinus sylvestris)* were planted. These throve well, and are now tall handsome trees adorning the waste. But during their growth it was observed that the damp places became dry; the snipes abandoned the locality; then two or three springs and a small stream that once flowed through the covert dwindled away, and at last entirely disappeared. Here was a surprise! The forestal functionaries set to work to discover, if possible, the explanation. They dug trenches six feet deep on the site of the springs, and made borings to greater depths. The trenches disclosed no appearance of water, but showed that the roots of the firs, as also those of the former oaks and birches, had penetrated six feet, or more, into soil. By the borings two underlying beds of water, one of considerable volume, were discovered; and the natural inference was that they had formerly stood at a higher level, and thereby maintained the springs; but in what way their level had been lowered by the growth of the firs was a question which could not then be answered, nor has a satisfactory answer yet been arrived at. The fact, however, remains, that trees included among the *Pinus* tribe exert a desiccating influence on the soil; and in the discussion occasioned by what has taken place in the forest at St. Amand, it has been mentioned that many of the lagoons on the south-west coast of France have been dried up and converted into woods by planting the maritime pine along their margins, and advancing the planting as the waters receded.'

*(To be continued.)*

## CENTRAL FACTORIES.—MARTINIQUE.

The following returns of some of the Usines in Martinique, for the year 1872, is taken from the *West Indian.*

| Usine. | Capital. | Tierces of Sugar. | Results obtained per cent. |
|---|---|---|---|
| Marino ............ | £34,000 | 2100 | 7·92 |
| Robert .... ...... | 56,000 | 2700 | 7·15 |
| Simon ............ | 30,000 | 1900 | 8·05 |
| Petit Bourg ........ | 48,000 | 2500 | 7·03 |
| François .......... | 48,000 | 2900 | 7·67 |

In the first Usine, (Marino) the planter was allowed 6 per cent. and the dividend was 21 per cent.; on the next three, Robert, Simon, and Petit Bourg, the planter was allowed 5½ per cent. of sugar on the cane, and the dividend was 20 per cent; in the last, François, the planter was allowed 5 per cent., and the dividend amounted to 34 per cent., attributable to the larger quantity of sugar made, and the smaller per centage allowed the planter.

# THE YIELD OF THE NEW DUTIES IN FRANCE.

From the *Revue Politique et Littéraire.*

## DUTY ON SUGAR.

During the past forty years the sugar question has been often before the Assembly; there are few subjects which have been discussed so frequently, and every time it has had this privilege, it has occasioned passionate debates, almost to the same degree as the hottest political questions. Thus it happened on a recent occasion upon a simple question of procedure, when the day for the discussion of the so-called "law of correlation" should be fixed, which will modify the collection of home duties; at one and the same time, four orators mounted the tribune, and it was with great difficulty after an exchange of reciprocal accusations, that it was at last possible to vote for the day of debate to be appointed.

## THE DEFICIENCIES AND THEIR CAUSES.

The intensity of passion which is raised in every discussion on the duty of sugars, arises from the great number of artificial interests which the duty has created, in introducing perturbations of all sorts in the economical natural results. At the present time there is a new cause of emotion added; it is the discovery of an immense deficiency in the return of duties in 1872. The receipts have not even reached two-thirds of their estimated yield, as it will be seen by the following table:—

DUTY UPON SUGARS IN 1872.

| | Estimate of the Budget.<br>£ | Actual Receipts.<br>£ | Deficiency.<br>£ |
|---|---|---|---|
| Colonial sugar | 1,851,800 | 1,243,880 | 607,920 |
| Foreign ,, | 986,880 | 631,360 | 355,520 |
| Beet root ,, | 4,003,600 | 2,345,760 | 1,657,840 |
| Totals | £6,842,280 | £4,221,000* | £2,621,280 |

*An error of two millions six hundred thousand pounds sterling!* It is by far the largest miscalculation in the Budget, not only in its absolute amount, but also its relative amount, for it represents much more than a third part of the expected yield.

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* Under this figure there remains £106,720 to be recovered in 1873.

The article subject to duty which next follows in this erroneous series, is that of beverages (spirits of wine, wines, beer, cider, perry, &c.), which only represents a total deficiency of £1,600,000 upon an estimate of £13,200,000, that is to say, of less than one-eighth. Tobacco has furnished £10,732,560, instead of £11,490,400, and showing a deficiency of £758,240, or one-fifteenth; the custom-house duties, amounting to £3,926,000 instead of £5,338,800, showing a deficiency of £1,412,800, or a little more than one-fourth. These are the most important losses. There are still some to be mentioned,—important not on account of their absolute value, but for their considerable relative proportion, —such as the deficiency of one-half on the duty on matches (£240,880 instead of £600,000), on chicory (£100,440 instead of £200,000), also of one-third on the sale of gunpowder (£373,680 instead of £633,240), and on the monetary postal revenue, £71,960 instead of £125,320; lastly, the reduction of £222,440 on the amount of the taxes on letters and newspapers, much to be regretted, although it represents only one-twentieth of this kind of income (£4,271,720).

Some of these miscalculations were not unexpected. Some have found their natural explanation, and some are already recovered. No one could expect from the custom-house dues the amount indicated by the budget, since the taxes on imported raw materials—admitting that they eventually become productive—are for the most part not as yet received. As far as the dues on matches and chicory are concerned, it was well known that their collection was not strictly enforced; the Ministry have at last decided to demand the monopoly of matches, and the adjudication of this monopoly to a co-interested administration, has secured to the State a revenue not only equal, but superior to the budget estimate. In the deficiency of £1,600,000 on beverages, £720,000 are applicable to Paris (£160,000 on alcohol, and £560,000 on wine and beer); this is the necessary consequence of the falling off in the working population, who formerly were attracted hither to engage in the construction of highways, sewers and buildings; this shows also the amount of suffering which has followed the two sieges, and their subsequent results. Again, the law for the inspection of breweries, the only adequate guarantee for the proper collection of this tax, has been passed too late to exercise any considerable influence on the receipts of 1872.

Lastly, the deficiency on tobacco of £758,240, is much more apparent than real. The increase of the tariff has not been applied during the first three months, and the collection of the duty in the departments occupied by the Prussians was almost impossible. But the two last months (November and December) have nearly produced £1,920,000,* equivalent to £11,920,000 for the entire receipts; and it is this amount we have a right to expect in 1873. If we compare this amount with the gross receipts of 1868 (£9,940,000), which has served as a standard for all the calculations we made last year,† we find a surplus representing a nett profit of £2,000,000, owing entirely to the increase in the prices of sale, and it is even accompanied by a diminution in the quantities sold, which will again economise to the State more than one million of raw product and of labour. The calculation (carefully studied) which we then published placed the profits of the reforms at £1,840,000. It will suffice here to refer our readers to this statement, for we have had the pleasure of seeing nearly all the essential combinations which we proposed adopted by the Commissioners of the budget, and by the Minister of Finances.‡ There is then no miscalculation on this point.

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* The documents do not show separately the receipts of the last months, but we have obtained this information from a most trustworthy source.

† *Revue Politique et Littéraire,* 10th February, 1872, vol. ix., pp. 775—786.

‡ The details will be found in the article above mentioned, and in that of the 24th February, 1872, p. 818. The Assembly has not yet voted the adjudication of the commission on tobacco, although for some time it has been occupied with the question of a proposition introduced by Mr. Lamberterie; and it has not suppressed the tobacco supplied to the army, nor the bonding warehouses in those towns where the manufacture is carried on, nor the tobacco magazines. We had estimated the yield of these three measures at £288,000.

But it is far from being the case with the duty on sugar. There the deficiency presents colossal proportions, which cannot be explained by ordinary causes. Let us examine the extent of the evil, before we begin to trace it to its sources. It will be easier to follow the facts by calculating directly on the quantities submitted to duty, and which represent the legitimate consumption, laying aside the amount of the receipts. We give here in round numbers the annual consumption for seven years.

SUGAR SUBMITTED TO DUTY.

| | |
|---|---|
| 1866 | 268,000 tons. |
| 1867 | 269,000 ,, |
| 1868 | 266,000 ,, |
| 1869 | 278,000 ,, |
| 1870 | 243,000 ,, |
| 1871 | 284,000 ,, |
| 1872 | 182,000* ,, |

Let us now take the mean of the last four normal years (1866—1869), we obtain the amount of 270,000 tons. But we have to deduct the consumption of Alsace, and of that part of Lorraine ceded to Germany—an allowance which the Commissioners of the budget and the Minister of Finances have omitted to take into consideration in their estimate of the duty. According to the census of 1866, the population of these territories represented six per cent. of the total population of France (1,597,238 inhabitants on 38,067,094). We have, therefore, to deduct six per cent. of the mean consumption, or, in round numbers—

16,200 tons;
Leaving 253,800 ,,

Moreover the census of 1872 shows, for the present territory of France, a diminution of 366,935 inhabitants since 1866. This is a falling off of about the hundredth part of the population, ascertained at this recent period, upon the same territory (36,469,856 inhabitants). Consequently we have to deduct the hundredth part of the former mean consumption, say

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* This last amount has not yet been published, but we have it on private information of very high authority.

2,540 tons.

We obtain thus, as the actual normal consumption, in round numbers,

251,000 tons.

Now let us compare this normal consumption with the effective results. There has been taxed :

| | | |
|---|---|---|
| In 1870 | 243,000 | tons. |
| In 1871 | 284,000 | ,, |
| Total | 527,000 | ,, |

This is 25,000 tons above the normal consumption in two years. Can it be said that we have passed this normal consumption? Not in the least. The surplus of 1871 has been employed—first, to replace the stocks of wholesale and retail grocers, exhausted during the war; then to clear of duty, in *anticipation* of the change, those sugars which were to be consumed in 1872. In this the manufacturers had a great interest, as will be seen. Since the war the duty on sugar has been raised twice—first by three-tenths, and later by another two-tenths. These additions must naturally be followed by a corresponding rise in the price of retail sales. In paying the duty in anticipation, on sugars which were to be consumed later, the refiners gained by the increase of prices, without suffering by the increase of the duty.

We may therefore add to the ascertained consumption in 1872 the 250,000 tons of surplus for the united years 1871-1872, and we shall have for the total of the tax relating to this year :

| | | |
|---|---|---|
| Anticipation in 1871 | 25,000 | tons. |
| Quantities taxed in 1872 | 182,000 | ,, |
| Total | 207,000 | ,, |

The normal consumption being 251,000 tons, there remains a deficiency of 44,000 tons, of which we have to discover the cause.

The attempt has been made to reduce this deficiency by representing that the sugar cleared in anticipation by far surpassed 25,000 tons, because, by the Prussian occupation, a large quantity of German sugar was introduced into our territory, without paying any duty. This is true, but only to a limited extent. What proves this is, that the quantities on which the duty was paid in 1870 are little inferior to the normal consumption: that year, however, could not give rise to any anticipatious clearances,—for no notification had been given of any increase in the duty,—and during four months of this year, consumption had been restricted by the partial or complete severance of several sugar consuming districts. Besides, it must be remembered that the Prussians, far from being able to inundate our territory with foreign sugar, had often great trouble to supply themselves with this commodity. The plea raised has therefore very little weight, when counterbalanced by the exceptional consumption which always attends the concentration of armies. At any rate, it cannot surpass the difference between the quantity taxed in 1870, and the normal consumption, that is, 8,000 tons. There still remains a deficiency of 36,000 tons. We do not hesitate to say that this is due almost exclusively to the false assessment of the duties, and to the frauds thereby induced. To demonstrate this, we will give a rapid sketch of the very instructive history of the tax.

### The Sugar Duties under the Old Regime.

Up to the time of the first Empire, sugar was exclusively a colonial article, so called even to the present day, obtained from the sugar cane. This plant was cultivated in the Antilles, the countries bordering the Indian Seas, and other intertropical colonies; the juice of the cane was obtained by pressure, then concentrated, and manufactured into a more or less yellow powder or raw sugar, which was then sent to Europe. These raw sugars not being in a fit state for ordinary consumption had to be *refined*, that is, to be freed from their impurities and to be made into white or candied sugars. This second operation formed a distinct industry, which naturally established its works in the principal ports, such as Marseilles, Bordeaux, Nantes, &c.

Under the old *régime*, when the king was regarded as lord and first proprietor of the colonial estates, a tax was levied upon the principal productions of these countries under the form of dues, paid at first in kind, but afterwards in money: this constituted the *Dues of the Possessions of the West*,* dues which varied very much from time to time, according to circumstances. Several dues were levied, but the principal amongst them were the duties on sugar.

As it was a territorial right, these duties ought to have been paid on the spot, in the colonies; but for the convenience of commerce the dues were only enforced when the merchandise arrived in the French ports, where they were to be sold. The buyer paid the duty at the same time as he paid the price for the sugar, and neither did the shipper of the cargo or the colonial producer pay any duty beforehand. In this manner the sugar industry was divided into two distinct branches. The *manufacture* by necessity established in the colonies themselves which produced the raw material, too bulky to be imported by itself, and the *refining*, which, in conformity with the principles of protectionism and the colonial treaty, reserving to the national European labour the right of working the colonial products, was centered in the metropolis. It is this primitive organization which, in perpetuating itself, has created all the present difficulties.

### THE BEGINNING OF THE BEETROOT SUGAR MANUFACTURE.

The continental blockade gave rise to a new sugar industry, that of beetroot sugar. Napoleon had prohibited the introduction of colonial products into Europe, to render worthless in the hands of the English the supremacy over the seas, which they then possessed without a rival. It was necessary to find a substitute amongst indigenous products to replace this commodity. Chemists occupied themselves with the question, and pointed out several plants containing sugar, and which could be produced in our soil. The beetroot was considered to be the best and the richest in sugar, although containing much less than the sugar cane of the colonies. People set to work to cultivate this plant in those departments which now constitute Belgium, and in the northern parts of France, and no encouragement was wanting at the hands of the Emperor in order to insure this industrial triumph over England. The extraction of sugar was far more difficult with a plant being only half as rich as the sugar cane, and to aim at producing at once white sugar fit for consumption, would have still more complicated the problem. It was a sufficiently high ambition to aspire to manufacture *cassonades* similar to those of the colonies. If this could be attained, there were the deserted refineries in the southern ports, waiting anxiously for the promised manna, which should replace the colonial sugars which they could no longer obtain. Thus, the manufacture of beetroot sugar organized itself, like that of the colonial sugar, into two distinct branches, destined soon to become antagonists: the manufacture, which was essentially agricultural, and the refining, preserving its commercial character. It is needless to state how unpretending and difficult were the beginnings of beetroot sugar manufacture, notwithstanding the subsidies granted, and notwithstanding the famine prices which the interdiction of foreign sugars occasioned.

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* They obtained their name by their having been granted, in the 17th century, to different companies, which had commercial privileges with the Western Colonies, that is, the Antilles and America. Besides, it was there where the principal French Colonies produced sugar.

Even in ordinary times the price of sugar was already very high, consequently the consumption was very limited; in 1817, after the complete restoration of communications, the entire consumption in France was 17,000 tons.

The fall of the Empire, causing the fall of the continental blockade, reopened the French refineries for colonial sugars. On arrival in our ports, they naturally found the duties, which they were accustomed to pay, revived and increased. The law of the 28th April, 1816, assessed them at 18s. 4d. per cwt.

As for the beetroot sugars, these, of course, escaped, since they were grown in the country, and no special law for taxing them was dreamt of. This Napoleonic industry appeared to be a still more artificial institution than the great Empire itself, the ruins of which spread over Europe, and it was not supposed that it would be able to survive. Its insignificance proved its safety, for at this period a duty would have annihilated it. However, it flourished rapidly and increasingly developed its production, and in the northern departments, where it was especially centred, called into existence refineries for the purpose of making sugar suitable for direct consumption.

An important competition thus sprung up affecting not only the colonial planter but also the refiners of the ports, placed as they were nearer to legislative power, and enjoying a greater influence in Government affairs, particularly at this period of high electoral franchise.

They appealed to justice, which, they said, could not allow the native sugar to be exempted from the duty to which colonial sugar, just as French as the beetroot, was subjected; and they sounded loudly into the ears of the Assembly the claims of an interest which has always been dear to French Assemblies, namely, that of the mercantile marine, the necessary training school for the navy. The production of beetroot diminished to that extent the consumption of colonial sugar, and thereby damaged the trade of the French shipping, which brought it to France. Consequently, they represented it was producing the decline of our maritime power.

It is noticeable that the arena of this strife was an unfavourable one for the beetroot industry, since it was driven to invoke the aid of protection, and that against the patriotic party, a circumstance which rendered the position as indefensible as a question of right as it was false from an economical point of view.

Consequently, by the law of 1836, the beetroot was subjected to taxation, the tax being gradually increased in order to allow the industry to adapt itself to the new *régime*. The amount to be paid was 4s. 1d. per cwt. in 1836; 6s. 1d. in 1838; and lastly, 10s. 2d. since 1840; this was not equivalent to the duty paid on colonial sugar, but the hope was entertained that the amount would prove sufficient to protect the colonial industry against the encroachments of the beet, if not to crush the latter altogether.

These beet duties were calculated upon the refined sugar, but it was impossible to levy them directly upon the refined, because it would have been necessary to extend the same principle to the colonial production and consequently to subject the refiners of the ports to custom house inspection. This would have constituted a veritable revolution, for which at that time no necessity was foreseen. Very naturally, the traditional principles of taxation, long established upon colonial articles, were adopted in the taxation of the beetroot. The raw sugar, or *cassonade*, being in fact nothing less than an admixture of diverse foreign substances or impurities with sugar, forming about one-third of the total mass, a legal estimate of yield was fixed upon, by which the presumable quantity of pure sugar, contained in a certain quantity of raw, might easily be determined, that is to say, the yield which the refiner could extract, providing the legal presumption to be exact. This was raised to 70 per cent., in 1840. This done the duty is easily charged upon the raw sugar, since it is known how much pure sugar is contained, in the eye of the law, in each hundredweight of the raw.

Thanks to this method, the refiners preserved their freedom, as before, and the supervision was confined to the beetroot factories, to provide that no beet sugar left to enter a refinery without having paid the duty.

Those interested in the beetroot protested that the passing of the law of 1836 would exterminate them, and they were the more readily believed, as this law was the cherished project of interests both numerous and powerful.

Nevertheless, they survived, and thanks to the economical improvements supplied by the discoveries of science, the expiration of 1840 did not witness any substantial check on their growth and development.

Mistaken in their hopes, the colonial refiners returned to the charge, crying out for more radical measures which should more than counterbalance the course of progress in the industry. On the 10th of January, 1843, M. Cunin-Gridaine, Minister of Commerce in the Guizot cabinet, laid before the Chamber of Deputies a proposition amounting purely and simply to the dispossession of the beetroot manufacturers for the benefit of the mercantile marine, allotting to the dispossessed manufacturers an indemnity of £1,600,000, to be paid in five years. But good fortune had secured friends to the beetroot industry, its electoral influence had increased with its prosperity, and already foreshadowed the importance it was to acquire under the second Empire. Henceforward it was necessary to recognize it as a power, and the Chamber hesitated to pronounce the death sentence which M. Cunin-Gridaine demanded for it. Moreover, the general principles which applied to the colonial industry in 1836 now recoiled against it, and the vantage ground for the struggle which the beetroot had contrived to select for itself lead to its victory, at least in a relative degree.

The law of July 2, 1843, did no more than to enact that the duty on beetroot sugar should be progressively raised from year to year, in such a gradation that in September, 1847 it should equal that on colonial sugar.

(*To be continued.*)

PREPARATION OF A STRONGLY-DECOLOURISING ANIMAL CHARCOAL. —Dr. Graeger.—The common powdered bone-black is first mixed with from four to six times its bulk of a solution of from 4 to 5 per cent. of crystallised carbonate of soda, and boiled therewith for some time; next it is washed by decantation, and, after that, treated with a large excess of dilute hydrochloric acid, sufficient, not only to dissolve the carbonate, but also the phosphate of lime it contains. (In order to see whether enough acid had been added, a small sample of the previously-filtered fluid is tested by means of ammonia, which, when added in slight excess, should not produce a turbidity.) When the mineral matter is removed, the charcoal is thoroughly washed, first by decantation, and next placed on a filter and washed until the water exhibits no acid reaction; the material is then carefully dried at from 100° to 120°. 100 parts of crude animal charcoal yield 20 of the purified, which has highly decolourising properties. The method requires time and patience.—*Bayerisches Industrie und Gewerbe-Blatt.*

## THE SUGAR DUTIES IN FRANCE.

The French Assembly has at length been in earnest in its determination to grasp and deal with the question of the imposts on sugar, and has devoted nearly the whole of three sittings, viz., the 14th, 15th, and 16th ult. to the vexed question. Two bills were before the Assembly for consideration ;—one, that brought in by the Government, which had for its apparent object the substantial confirmation of the present faulty system. It was, however, provided that analysis should be resorted to in doubtful cases, but the modifications proposed by this measure would do little to relieve the French Treasury from the heavy abstractions which are now openly avowed. Indeed, it is asserted by authorities that the present evils would be aggravated. M. Dupont estimated the prospective loss to the revenue by this measure at about one million and a half sterling annually. The second bill was intended to establish the system of refining in bond, or the payment of the duty upon sugar as it leaves the refinery for consumption. We have not space to follow the interesting and lengthy debate that ensued, but the Assembly, it is understood, was prepared to accept this rational method for putting a stop to the present system of legalized fraud, but in order to avoid undue haste, the debate was postponed for a few days until the second reading of the bill. A few months ago it was the custom for the upholders of the present system to deny that any bounty was received on export, and, in fact, when the deputation of English refiners appeared last summer before the Superior Council in Paris, they were met by the assertion that the French refiners denied emphatically that by the system of duties they enjoyed any bounty or protection whatever. It is to be believed that the Paris refiners think somewhat differently at the present time, for if they receive no such bounty they will have little cause to complain of a system for withdrawing bounty, and placing them on a fair footing with their competitors, and therefore will have little cause for the disappointment and despondency they were said to manifest as the debate proceeded. These bounties are, in fact, now openly .admitted. M. Say, the

Minister of Finance, and relative of the eminent refiner of the same name, admitted and deprecated the bounties; whilst M. Pouyer-Quertier estimated the losses to the Treasury at from £800,000, to a sum twice as great, annually. He also pointed out that the four months' credit granted by the Government to the refiners in the payment of the duties, taking into consideration the present rate of duty, and the time required for the process of refining, was equal to an actual subsidy without interest, to a single refiner, of a quarter of a million sterling!

Thus, M. Pouyer-Quertier has demonstrated that the refiners of France have been furnished by the Treasury, first with capital to carry on their business, and then the duties have been so imposed that they have had from £800,000 to £1,400,000 distributed among them, first, to share with the producers of certain undertaxed sugars; second, to meet the charges of conveying their refined sugars to England and elsewhere; and third, for the production of the colossal fortunes they have not forgotten to amass.

## CULTURE OF THE SUGAR BEETROOT.

### PREPARATION OF THE SEED.

The experimental establishment at Salzmünde, has just published the results of a series of experiments relating to the growth of the beetroot. The experiments have been conducted with the exactitude which the Germans always apply in their scientific researches, and which gives so much authority to their works. The Beet seeds were planted, in equal number, in pots containing an equal quantity of very poor sandy soil, carefully sifted and mixed; the different quantities of seed were moistened with carefully measured quantities of distilled water. For the full confirmation of the results obtained, the experiments were repeated several times, and the observations made tend to establish the following facts:

I. The depth at which the seed is sown has an influence upon the raising of the young plants, in a threefold manner, viz:

A. Upon the length of time required before it begins to vegetate. The seeds covered with one centimetre (0·393 in.) of soil, struck the first, the others as much later as they were deeper in the soil; under four centimetres of soil, (1·372 in.) they sprouted in a day and a half, under six centimetres (2·368 in.) two and a half days, and under nine centimetres (3·737 in.) five days later than those which had been covered with one centimetre of soil.

B. Upon the germinative power of the seed. Sown at the depth of one centimetre, the seed produces three sprouts, at five centimetres only two, and at eight centimetres only one sprout.

C. Upon the strength of the young plant. The vigour of the young plant dimishes in proportion to the depth at which the seed has been sown, because the germ loses its strength, in pushing through a thick layer of soil, and does not receive the benefit of light and heat as soon as when it is sown at a depth of only one centimetre.

2. When the seeds have been sown in one, two, or three centimetres of soil, there is not much difference between the plants; it is only where the depth reaches, or passes five centimetres, that a notable difference is perceptible. In practice there will be no need to sow deeper than two or three centimetres; at one centimetre the seed would run the risk of wanting the necessary humidity, particularly during a dry season.

3. The experiments relating to the influence exercised on the growth by the atmospheric air have proved, that a layer of stiff clay put upon the seeds so as to prevent the access of air, delays the germination, and is injurious to the strength of the young plant; in this experiment the injurious action is in proportion to the thickness of the layer of clay.

4. The division of the surface of the soil (as by harrowing) during the germination, has a very favourable influence upon the force and rapid development of the germ.

5. The seed can be soaked in water more than twenty four hours without injury to their germinative power. This operation appears to be unnecessary, having had no other effect than to hasten the sprouting of the seed by half a day; it is, however,

possible that this would show itself of greater utility in a dry season and in a dry soil.

6. Considering the germination only, it appears equally unnecessary to mix the water in which the seed is put to soak with any chemical substance. Those seeds which have been soaked in pure water have always appeared the best in the experiments.

If it is sought to supply the young plant in this manner with a strengthening agent of which the effect should be sufficiently durable in certain climatic circumstances, compounds of a nature to be useful to vegetation might be added to the water. Saltpetre and weak nitric acid are substances of this class. There are certain energetic agents which should be avoided as dangerous, such as fresh urine, lime water, or chlorine water, common salt, carbonate of ammonia, chloride of lime, etc.

7. If before sowing, the seeds are rolled in manures or salts, so that they become covered with a crust of such manures, very different results are obtained. The seeds thus prepared have sprouted later and have produced one third fewer of young plants. Probably a proportionate number of sprouts were destroyed by rolling the seeds in the substances forming the artificial crust. However there still remained sufficient of the two-thirds to ensure a good crop, and this covering of the seeds would still be advisable if it were proved that it hastened the growth of the young plants during any considerable period of their vegetation. Such were the results obtained at Salzmünde, by experiments on a small scale: the plants obtained from prepared seeds showed themselves the most vigorous during the whole of the first month of their vegetation. This, however, is not conclusive enough to adopt the mode of preparing the seeds, without further trials, for the utility of this covering could only be proved by trials on a large scale in open fields, where we have to consider inclemencies of weather which might influence the germination. Care should be taken in the selection of the substances which are to be used in the operation, it is preferable to use superphosphates, Chili saltpetre, or bone dust; powdered lime, guano, sulphate of iron, and all ammonia salts ought to be rejected.—From *La Sucrerie Belge.*

## THE "CANE BORER" IN THE MAURITIUS.

The damage caused to sugar canes by that insidious pest the "Borer," attained so great dimensions in the Mauritius a few years ago, that as will be remembered, the Governor of that important Island appointed a Committee or Commission to investigate the subject, and to propose a remedy. The valuable report issued by the Commission is worthy the consideration of the planters in other Sugar Colonies, as few are so fortunate as to be entirely exempt from the scourge of this terrible insect. We therefore reproduce the substance of this report.

SIR,

The special Committee appointed by your Excellency for the purpose of examining the extent of the damage caused by the cane borer to the plantations throughout the colony, and of investigating the remedial measures capable of checking this scourge on our local agriculture, have the honor to lay the report before your Excellency.

Your Committee under the Presidency of Mr. W. Bojer, have been desirous to respond as early and as fully as possible to the solicitude of your Excellency in favour of the agricultural interests of this colony. In consequence, after appointing the Honorable C. Wiché and G. Tropier, the first as their Secretary, and the second as their Reporter, they commenced their investigations without loss of time.

The first care of the Committee, after having ascertained the presence and the nature of the evil, has been to publish a short notice containing the first precautionary measures, which appeared at first the most suited to check the propagation of the destroying insect, in order not to allow it time to multiply during the period necessary for its development; to study the duration of its transformations, its manners and habits, and to examine the best means of destruction applicable to the case.

The members of the Committee collectively or separately have visited, in all the districts of the island, upwards of forty estates, and they are able to state that the Borer exists now everywhere.

that the danger resulting from its presence was then, however, more threatening than positive.

The districts of Pamplemousses, Rivière du Rempart, Savane, Grand Port, and Plaines Wilhems, are those in which the insect was found in greater number, but it may be said that it has as yet caused great damage in those parts only of Pamplemousses and Rivière du Rempart, known under the denominations of "Grand Bay," "Mapou," "Butte aux Papayes," "Bois Rouge," at Moka, and at Flacq; the insect was at first found isolated, but its multiplication is so rapid that it may now be numerous in these districts, should the precautionary measures recommended not have been adopted.

In those localities that have suffered most, the drought has no doubt contributed much to the deficiency experienced in the crop; but considering the disorganised state of many of the canes, evidently caused by these destructive insects, it would be deceiving oneself, not to attribute to their ravages a large proportion of this deficiency, estimated, on several estates, at a third of the crop.

However, when the Committee consider that seven years have been required to give to this evil its present alarming proportions, they entertain the hope that, with proper precautions, it will be possible to check, if not to eradicate it entirely.

It must, however, be admitted that this task is much more arduous now than it would have been, if undertaken on the first appearance of the insect. On the other hand, the means at the disposal of man for an organised war against an enemy of such an inferior class, which has no other resource to avoid destruction than its great fecundity, are encouraging, and must be crowned with success if applied with the courage and the persevering care which the general prosperity of the island claims at the hand of every inhabitant.

We say that it has not required less than seven years for the evil to attain its present proportions, because it is possible to fix, in a manner almost certain, the period of the introduction into the island of this destructive insect.

Its presence has never been made known to any member of this

Committee, nor to any experienced planter, nor to any naturalist familiar with the local entomology, before the arrival of a certain quantity of canes from Ceylon, which Sir William Gomm, one of your Excellency's predecessors, had ordered with the view of regenerating, if possible, the various kinds of canes cultivated in the colony, and which appeared doomed to destruction by a disease which had existed for some years past at Bourbon, had just made its appearance at Mauritius, and was beginning to create alarm amongst the planters.

These canes arrived in the month of November, 1848, on board the Government schooner *Elizabeth.* A report had gone abroad, before their arrival, that all canes from Ceylon were attacked by a Borer, and that it would be dangerous to admit those that were expected. This opinion was made known to Sir William Gomm, by the report of the Agricultural Committee of the Royal Society of Arts and Sciences, who in consequence charged the Committee appointed on the disease in cane, to inquire into the truth of this assertion, and to determine whether it was prudent to admit the suspected cane plants. The members of that Committee, of whom were two of the undersigned, were informed by the relations and friends of a planter from Mauritius (Mr. Chermont,) settled for some years past in Ceylon, that the borer in question was a real scourge upon the cane plantations of that Island, and they soon acquired the certainty, on inspecting the canes which had just then arrived, that they were almost all perforated by that insect, which they saw for the first time. In consequence, they recommended the immediate destruction of these canes. It is, however, supposed that some of these cane plants which remained for some days deposited under a shed in front of the post office, may have been taken and planted by some imprudent persons,—whatever may have been the case, it is but too true that, two years afterwards, the Honorable Captain West, made known to the Royal Society of Arts and Sciences the damage caused by that insect on his estate, situate in the same district of Grand Bay which is now so ill treated.

*(To be continued.)*

## NATAL.

Our colony now well advanced, retains its character for exceptional wetness. Clouds and rain are the common experience, and fine, sunny days are rare. This fact, combined with the scarcity and dearness of labour, will not only throw back present crops, but materially curtail the sugar crop of 1873-74, as little new ground has been planted, and many new fields will be cut too late to ratoon in time. We anticipate that the labour pressure will not last much longer. As soon as Coolie Immigration is resumed, native labour will cease to be of so much importance, and will probably increase in supply. The influx of natives from the interior can scarcely fail to advance, and the labour market will balance itself. Colonel Lloyd has entered upon the important duties of his office as Protector of Immigrants, and we may soon hope to hear that the Home and Indian Governments have agreed to the resumption of emigration hither. Several large sugar-planting enterprises are only awaiting the satisfactory settlement of the labour question in order to begin operations.

The prevalence of rain has been common to the whole colony, and considerable injury has been done to the corn crops up-country. We are glad to learn, however, that there is a good prospect of a large crop, the yield in many cases being very promising, and fields fairly forward. Maize has seldom been so scarce and so dear as it is now, the current price in Durban being 33s. a muid, or 11s. a bushel. As there is now certainty of a large crop, prices may soon be expected to fall.

The prevalence of sickness amongst cattle is probably a result of the season. Both lungsickness and redwater are carrying off large numbers. In a country like this, effectual measures of repression are not so easy. Farms are so scattered, and general usage is so averse from all forms of restriction, that "stamping out" measures meet with special opposition. This has been very manifest in the case of the Scab Bill—a measure which was both supported and opposed with much vehemence. A large body of sheep-farmers strongly protested against its enactment on account of its inquisitorial and arbitrary provisions. A large body also supported it as required in order to protect the careful and watchful flock-master from the reckless indifference of his neighbours. After passing through all its stages, the bill was thrown out in committee.

Sugar.—Crushing at the mills has been much retarded by the almost incessant rains. It is with regret we have to report that on some estates the yield will not nearly come up to what was estimated at the commencement of the season. It will be hard upon some of the smaller planters, who had looked forward to this season with great hope. The orders to hand for sugars are not very large, but on account of the dearth of receipts, difficulty is experienced in satisfying them. The prices we have to quote now are:—

| | | |
|---|---|---|
| White Crystals (vacuum pan), 1st quality | 29/0 to 30/0 | per cwt. |
| White Crystals, do., 2nd quality........ | 27/6 to 29/0 | ,, |
| White Crystals (wetzel pan) .......... | 25/0 to 26/0 | ,, |
| Light yellow Crystals ................ | 23/6 to 24/6 | ,, |
| Light yellow counters ................ | 23/0 to 24/0 | ,, |
| Yellow ordinary .................... | 21/0 to 22/0 | ,, |
| Grey, dry and grainy ................ | 20/0 to 21/0 | ,, |
| Syrups, best light.. ................. | 19/0 to 20/0 | ,, |
| Do., dark yellow, and brown........ | 17/0 to 18/6 | ,, |
| Do., low brown .................... | 15/6 to 16/6 | ,, |

## Correspondence.

### TREATMENT OF WORKING MEN IN MIDDLESEX AND IN DEMERARA.

To the Editor of "The Sugar Cane."

Sir, Feb. 16, 1873.

A labouring man in this parish, whose wife is blind, had to leave off work on Saturday, the 8th of this month, owing to severe illness. On the 13th, being no better, he was obliged to send for the doctor, who gave him a note for the Relieving Officer, saying that a small quantity of meat and some porter were urgently required. As the Relieving Officer lives three miles off and the man was too ill to go himself, while his wife was incapacitated by her blindness, matters were only saved from coming to a deadlock by the kindness of a neighbour who volunteered to carry the note. On receiving it, the Relieving Officer declined to submit it to the Board of Guardians (then sitting) on the ground that it was informal, as the doctor had not sent full particulars of the nature of the illness, &c. The good natured neighbour took a second six mile walk for this purpose, and on the morning of the 14th the Relieving Officer was put in possession of the details he required. In answer to an appeal made as to the urgency of the case, he said, with perfect coolness, "I shall be over in —— on Monday next (the 17th) and I will look in and see the man, but I can't do anything till then."

If any addition to this simple statement were necessary, it might be as well to say that the sick man's poor little cottage of two rooms is saddled with a Poor rate of 9s. 8d. a year, which has been regularly paid.

Sir, such treatment of a sick labourer seems so improbable anywhere in England, that I could hardly expect you to believe it without the corroboration afforded by your knowledge of my name and address as one of your subscribers, nor can I hope that you will insert this letter in the forthcoming No. of *The Sugar Cane*, unless you can imagine the annoyance that has been caused to the employers of Coolie labour in Demerara by the reckless accusations of Mr. Jenkins, and those whom he represents. I need not repeat to your readers the neglect, cruelty and dishonesty we were supposed to be guilty of. I had to bear my share of the abuse that was heaped on all Demerara proprietors, till the Report of the Commission appeared and exonerated me. Having gone through this, can you wonder at my disgust on finding such a case as I have described, and that within fifteen miles of London? Why, if my manager had treated one of my Coolies *half* as badly, I should never have heard the end of it! If any of the Aborigines' Protection Society should chance to see these lines, I hope they will not misunderstand me: if I don't do my duty to my workpeople it is quite right that I should be punished for it, but there is ample machinery for that purpose already provided in the colony; and this Society, and others of the same character, might possibly do more good if they recollected the old proverb, "Charity begins at home," and provided such an organization as would prevent an English labourer in Middlesex being worse treated than a Coolie in Demerara.

Your obedient servant,

S.

Disastrous Fire.—On the morning of the 25th, the main building of the very extensive sugar refinery of Messrs. John Walker & Co., of Greenock, was destroyed by fire. Estimated damages £80,000.

## UNITED STATES TARIFF.

### Sugar and Molasses.

| | | |
|---|---|---|
| Sugar, all raw or muscovado, not above No. 7 Dutch standard, in colour | 1¾c. | per lb. |
| Do. above No. 7, and on all other sugar not above No. 10 | 2c. | ,, |
| Do. above No. 10 and not above No. 13 | 2¼c. | ,, |
| Do. above No. 13 and not above No. 16 | 2¾c. | ,, |
| Do. above No. 16 and not above No. 20 | 3¼c. | ,, |
| Do. above No. 20 | 4c. | ,, |
| Do. syrup of sugar cane | 1c. | ,, |
| Do. refined loaf | 4c. | ,, |
| Do. do. lump | 4c. | ,, |
| Do. do. crushed | 4c. | ,, |
| Do. do. powdered | 4c. | ,, |
| Do. do. granulated | 4c. | ,, |
| Melado, or concentrated melado | 1½c. | ,, |
| Molasses | 5c. | per gal. |
| Molasses concentrated | 1½c. | per lb. |

All syrup of sugar, syrup of sugar cane, juices, melado, concentrated melado, or concentrated molasses, entered under name of molasses, shall be forfeited.

## COLONIAL EXPORTS.

*(From Licht's Monthly Circular.)*

### MAURITIUS.

| From 1st Aug. to 10th Dec. | 1872-73. | | 1871-72. | | 1870-71. |
|---|---|---|---|---|---|
| | Tons. | | Tons. | | Tons. |
| **To England** | **24,608** | .. | **21,207** | .. | **8,319** |
| ,, France | 8,952 | .. | 12,592 | .. | 3,566 |
| ,, Australia | 20,002 | .. | 12,649 | .. | 16,168 |
| ,, New Zealand | 3,128 | .. | 1,987 | .. | 1,717 |
| ,, Cape of Good Hope | 708 | .. | 397 | .. | 1,261 |
| ,, Bombay | 6,544 | .. | 19,546 | .. | 11,430 |
| ,, Other Ports | 2,271 | .. | 1,269 | .. | 187 |
| Total | 66,213 | | 69,647 | | 42,648 |

### HAVANA AND MATANZAS.

| From 1st Jan. to 31st Dec. | 1872. | | 1871. | | 1870. |
|---|---|---|---|---|---|
| | Tons. | | Tons. | | Tons. |
| To Great Britain | 143,176 | .. | 68,301 | .. | 176,382 |
| ,, United States | 23,411 | .. | 195,960 | .. | 195,655 |
| ,, Spain | 39,870 | .. | 45,827 | .. | 59,789 |
| ,, France | 21,896 | .. | 12,600 | .. | 44,454 |
| ,, Northern Europe | 13,061 | .. | 8,915 | .. | 11,360 |
| ,, Southern Europe | 960 | .. | 634 | .. | 3,410 |
| ,, Other Ports | 58,231 | .. | 3,922 | .. | 8,296 |
| Total | 458,605 | | 336,159 | | 499,346 |

Stocks in Havana and Matanzas, 31st January.

| | 1873. | | 1872. | | 1871. |
|---|---|---|---|---|---|
| Hogsheads | 9,500 | .. | 10,800 | .. | 11,100 |
| Boxes | 72,100 | .. | 75,900 | .. | 69,500 |

### STOCKS OF SUGAR IN THE CHIEF MARKETS OF THE WORLD ON THE 1ST JANUARY, 1873, FOR THREE YEARS, IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

| | 1873. | 1872. | 1871. |
|---|---|---|---|
| Great Britain | 160 | 99 | 122 |
| France | 153 | 85 | 132 |
| Holland | 32 | 25 | 14 |
| Germany (Zollverein) | 40 | 37 | 43 |
| Six other *entrepôts* | 8 | 5 | 4 |
| Total in Europe | 393 | 251 | 315 |

### CONSUMPTION OF SUGAR IN EUROPE AND THE UNITED STATES, FOR THREE YEARS ENDING 31ST DECEMBER, IN THOUSANDS OF TONS.

| | 1872. | 1871. | 1870. |
|---|---|---|---|
| Great Britain | 715 | 662 | 664 |
| France | 224 | 327 | 314 |
| Germany (Zollverein) | 239 | 212 | 221 |
| Holland | 23 | 20 | 31 |
| Six other Countries | 95 | 113 | 95 |
| Total in Europe | 1,296 | 1,334 | 1,325 |
| United States | 564 | 540 | 466 |
| TOTAL | 1,860 | 1,874 | 1,791 |

### ESTIMATED CROP OF BEET ROOT SUGAR ON THE CONTINENT OF EUROPE, FOR THE ENSUING SEASON, COMPARED WITH THAT OF THE THREE PREVIOUS SEASONS.

*(From Licht's Monthly Circular.)*

| | 1872-73.<br>Tons. | 1871-72.<br>Tons. | 1870-71.<br>Tons. | 1869-70.<br>Tons. |
|---|---|---|---|---|
| France | 360,000 | 335,351 | 289,084 | 289,324 |
| Germany (Zollverein) | 255,000 | 189,166 | 262,986 | 217,192 |
| Austro-Hungary | 167,500 | 161,526 | 182,280 | 151,354 |
| Russia and Poland | 135,000 | 90,000 | 135,000 | 132,500 |
| Belgium | 75,000 | 72,236 | 55,739 | 43,552 |
| Holland and other Countries | 32,500 | 25,000 | 17,500 | 12,500 |
| Total | 1,025,000 | 873,279 | 912,589 | 846,422 |

## SUGAR STATISTICS—GREAT BRITAIN.

To 15th February, 1873 and 1872. In Thousands of Tons, to the Nearest Thousand.

| | STOCKS. | | | | | | IMPORTS. | | | | | | DELIVERIES. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. |
| British West India | 12 | 2 | 1 | 12 | 27 | 13 | 4 | 1 | 1 | 2 | 8 | 10 | 9 | 1 | 2 | 6 | 18 | 18 |
| British East India | 15 | 4 | .. | .. | 19 | 5 | 8 | 2 | .. | .. | 10 | 3 | 3 | 1 | .. | .. | 4 | 4 |
| Mauritius ...... | 4 | 1 | 1 | 1 | 7 | 10 | 2 | .. | 3 | 1 | 6 | 12 | 2 | .. | 3 | 1 | 6 | 9 |
| Cuba .......... | 2 | 1 | .. | 10 | 13 | 8 | .. | .. | 1 | 1 | 2 | 2 | 2 | .. | 1 | 3 | 6 | 4 |
| Porto Rico, &c. .. | 1 | 3 | .. | 5 | 9 | 3 | .. | 1 | .. | 1 | 2 | 1 | 1 | 1 | .. | 1 | 3 | 1 |
| Manilla & Java .. | 20 | 5 | .. | .. | 25 | 29 | 2 | 1 | .. | 2 | 5 | 15 | 3 | 2 | .. | 2 | 7 | 8 |
| Brazil .......... | 1 | 12 | .. | 3 | 16 | 16 | .. | 6 | 1 | 1 | 8 | 11 | 1 | 7 | 1 | 1 | 10 | 8 |
| Beetroot, &c. .... | 6 | 1 | 1 | 8 | 16 | 25 | 7 | 4 | 3 | 13 | 27 | 33 | 7 | 4 | 4 | 16 | 31 | 26 |
| Total, 1873 .. | 61 | 29 | 3 | 39 | 132 | 109 | 23 | 15 | 9 | 21 | 68 | 87 | 28 | 16 | 11 | 30 | 85 | 78 |
| Total, 1872 .. | 40 | 26 | 5 | 37 | 23 increase | | 23 | 18 | 10 | 36 | 19 decrease | | 24 | 17 | 10 | 28 | 7 increase | |

# STATE AND PROSPECTS OF THE SUGAR MARKET.

The course of the sugar market during the past month has not been marked by any extraordinary feature; prices for the first fortnight showed little or no fluctuation, notwithstanding the somewhat rapid decline of the stock; for the latter part of the month however, various causes, particularly bareness of stock in refiners' hands and the small show offering have had the effect of increasing prices for fair refining kinds fully 6d. per cwt. The continued prevalence of north-east wind is doubtless the chief cause of this comparative scarcity in the London market, whither the greater part of these qualities is destined. Floating cargoes are obtainable for less money.

Low raw sugars are not at present much in demand, the stock in the country and to arrive of this description being large; nevertheless, it is not improbable that the late improvement in the demand for the lower sorts of pieces, coupled with the present scarcity of finer raws, may bring about some reaction in their favour. Fair cane jaggery can now be purchased at 19s. duty paid.

In regarding the future, it is impossible to overlook the political situation in Spain and the complications to which it may give rise in Cuba in connection with the question of slavery, complications which certainly cannot tend to improve the immediate aspects of the sugar industry of that island. On the other hand, the recent debates in the French Chamber, pointing, as they do, to the abolition of unfair legislative advantages, give assurance that whatever may be the immediate effect of the measure, if carried, upon the various interests concerned, the ultimate result must be to promote the healthy growth and well-being of the sugar industry.

Quotations of the prices now current for the various qualities of raw, contrasted with those of last month, show little variation. No. 12 Havana afloat is worth 27s. 6d. per cwt., the same as last month; fair, to good refining Cuba muscavadoes 24s. to 25s., or an advance of threepence; middling, to good brown Bahia 20s. to 21s. 6d., also an advance of threepence; good, to fine Pernambuco 21s. 6d. to 22s. 6d. against 22s. to 23s. at the end of January. Stocks at the four chief ports have considerably decreased during the month; indeed, having regard only to the present relations of stock and price, and ignoring the acknowledged fallibility of statistical predictions, a rising market might be prophesied; and it would, in any case, be difficult to anticipate a permanent decline.

The refined market is steady with a fair demand, the stock of refined held by grocers is not large, and the dislocation of commerce occasioned by the dearth and enormous price of coal, has not hitherto, so far as we are aware, been the means of closing any of the refineries.

THE
SUGAR CANE.

No. 45. APRIL 1, 1873. VOL. V.

☞ The writers alone are responsible for their statements.

*For Table of Contents, see opposite the last page of each Number.*

## REMARKS ON SULPHITE OF CALCIUM.

### BY DR. B. W. GERLAND.

The very large and rapidly increasing use of sulphurous acid and its preparations, more especially the sulphites of calcium, in the sugar industry, will probably induce many of the readers of this journal to interest themselves in the properties of these compounds. Together with other sulphites, that of calcium has been credited with a great absorbing power for oxygen, and even Dr. Icery dwells upon this supposed rapid change in contact with air, and on the strength of it insists upon its preparation at the place and time of consumption.

After having shown the indifference of the sulphite of calcium phosphate (see *Sugar Cane*, vol. II. p. 40) to the influence of the atmosphere, I subjected the calcium sulphite to a series of experiments, and found it to possess almost as little liability to oxidation as the former. The following experiment will sufficiently illustrate how slowly oxidation progresses with the calcium sulphite, even when favored by moisture and higher temperature.

Milk of lime was treated with an excess of sulphurous acid gas, drained on a filter, washed, and left in a stove to dry slowly. The amount of sulphuric acid in the sample was found to be very small: it was again mixed with water and exposed in the drying stove, where it remained for three days, after which it was heated in an air bath for two hours to 130° Celsius (266° Faht.). The analysis yielded the following numbers :—

| | |
|---|---|
| Sulphurous acid (sulphuric dioxide) ...... | 48·27 |
| Sulphuric acid (sulphuric trioxide)........ | 2·34 |
| Lime ............................. | 44·74 |
| Difference (water, &c.).................. | 4·65 |
| | 100·00 |

Oxidation had made so little progress under these trying circumstances, that only the twenty-sixth part of the sulphuric dioxide had become sulphuric trioxide. This sample was prepared with an excess of sulphuric dioxide, but others, in which the reaction was made alkaline by means of lime water, did not absorb oxygen from the air any quicker, when subjected to the same conditions. The calcium sulphite, when prepared in the dry way by passing the fumes of burning sulphur over slaked lime, behaves in a similar manner. The commercial article is generally prepared by this method, and seldom contains above three per cent. of sulphuric trioxide. As an illustration, I give the analysis of a sample of calcium sulphite from Messrs. W. Bailey & Son, of Wolverhampton. It is a fine white powder, and was kept in a corked bottle.

| | |
|---|---|
| Sulphuric dioxide..................... | 48·20 |
| Sulphuric trioxide .................... | 1·96 |
| Lime .............................. | 42·96 |
| Magnesia ........................... | 0·32 |
| Silica .............................. | 0·29 |
| Difference (water, &c.).................. | 6·27 |
| | 100·00 |

The preparation on the sugar plantation of the comparatively small quantities of calcium sulphite required for the defecation of the cane juice must cause great inconvenience, particularly as the apparatus required for its manufacture can only be occasionally used. That the planters can procure from this country a cheaper, purer, and more reliable sulphite of calcium for their purpose, than any they can produce on the spot with comparatively imperfect chemical appliances, is to my thinking a fact well worthy of their earnest attention. There is no difficulty whatever in shipping the sulphite, either as dry powder or as paste, if the latter form should be preferred.

Sulphurous acid and lime form only one definite compound, and what is known as "acid sulphite," or "bisulphite of lime," is merely a solution of calcium sulphite in water charged with sulphurous acid. By passing sulphuric dioxide into milk of lime until it was saturated, I obtained a solution containing in 1000 c.c.—

| | |
|---|---|
| Sulphuric dioxide ................ | 89·960 grm. |
| Lime ......................... | 2·582 ,, |

According to this estimation, the solubility of calcium sulphite is very small, but that a solution of greater strength can be obtained is proved by the following analysis of Messrs. Bailey & Son's "bisulphite of lime":—

The sample contained in 1000 c.c.—

| | |
|---|---|
| Sulphuric dioxide .................... | 41·018 |
| Sulphuric trioxide .................... | 1·182 |
| Hydrochloric acid .................... | 0·207 |
| Lime .............................. | 18·375 |
| Magnesia .......................... | 0·276 |
| Peroxide of iron and alumina .......... | 0·185 |

There are actually in this bisulphite two molecules of acid for each molecule of base. This solution however, as might naturally be expected from its character and strength, requires to be kept in good casks or other well stoppered vessels, in order to prevent a partial loss of its sulphurous acid, and consequent deposition of the calcium sulphite in the crystallized form.

# AGRICULTURAL REPORT OF ANTIGUA.

By Dr. Freeland.

The early months of 1872 were very dry, a great scarcity of water throughout the Island prevailed; ponds and streams were nearly all empty; estates, after planting and replanting, were unable to establish the crop before September, when the dry weather broke up in a cyclone accompanied with a fall of about eleven inches of rain.

The rain, although unusually late, finding the plants hardly growing and the ratoon sprouts only alive, continued, fortunately, in heavy showers from the beginning of October to the end of December, with barely an intermission of forty-eight hours.

As the wet season commenced late, in fact before the plants were yet established, and a more than usual irregularity in the ratoons everywhere apparent, it is certain, but for the very forcing weather which we have since experienced, that the crop of 1873 would have been very short.

It is remarkable that we should, even in this apparently wet season, still have to notice the great partiality of the rainfall, which has varied for the year between the middle and windward districts from 49·11 to 25 inches; the former representing a tract in some degree hilly, wooded, and seasonable; the latter showing up, as usual, a locality equally notorious for its lack of moisture, its level surface, and its light soil.

Although we note then over forty-nine inches of rain in the centre of the island, we can by no means consider this as favorable; for we find quite two-thirds recorded only within the last four months; besides, by reference to our table we see, 1867—54·76, 1868—58·24, 1869—60·66, 1870—53·03, 1871—45·67, and as the rainfall for the first nine months in each year generally shows little variation, a want of similarity in the period just passed unquestionably demonstrates it as a dry year; indeed the constantly recurring showers of the last three or four months go some way to prove by their partiality that 1872 had really no wet season.

January, 1873, was wet, the quantity of rain recorded being 4·16 against January, 1867—2·15, 1868—2·07, 1869—3·15, 1870—3·20, 1871—2·40, 1872—1·91. Showers were frequent and at short intervals to about the middle of the month, when a strong north-east wind set in with marked indications of drier weather. The retentive nature of the soil, however, still keeps up the growth of the present crop, and enables us in a great measure to secure the vitality of the next.

December, January, and February are our planting months; experience having proved, beyond the possibility of a doubt, that this is the proper season, and that in nine cases out of ten we do wrong when we plant earlier; we, nevertheless, notice great anxiety in certain quarters to anticipate the appointed time, by giving way to the temptation of securing the growth of the fields in October or November, when perhaps the showers are frequent and heavy. We say, therefore, everything when we designate it as a temptation; and we remind those who may be so tempted, to consider well the ill effect a few dry months will have on plants in any measure advanced.

The canes are everywhere green and growing, in some districts we observe a sufficiently forward state generally, with a length of reed quite equal to anything we have witnessed in past years; but in other localities, and on particular estates, we remark that the fields are by no means so forward as we might desire, nor do we think these will be likely ever to attain any length in the present season, unless, indeed, we should unfortunately have a wet harvest, when losses will arise quite equal to any advantage gained by extra growth.

Most estates (with perhaps the exception of the fields from which the supply of plants was obtained) have all their lands prepared, planted, or growing.

In collecting plants it is desirable to be particular, and we notice, lately, some anxiety evinced for the care and preservation of fields appropriated to the supply; the mode of separating the plant is also well understood, and the fact that the less saccharine placed in the ground, the greater immunity from acidity and insects is likewise appreciated. Some planters, who advocate soaking doubtful plants for ten or twelve hours before they are used, admit the inutility of adopting such a measure in wet weather, and this we think reasonable, for nothing is really gained by it except the elevation of a badly developed eye, or, perhaps in dry seasons, it may act favourably by washing away and destroying minute insects which sometimes injure the growing plants.

We notice that the drill is the planting implement now commonly used, and although, it may no doubt be more certain in its effects in dry weather, or on ill prepared, badly drained, and only recently opened ground, we question, with the present fine tilth and good drainage, if we might not be equally as successful, and ultimately reap a heavier return by introducing again the now discarded hoe.

The original purpose in the use of the drill was that a deep vertical, close, and unbroken hole should be made for the reception of a plant at least ten inches long, and long enough to touch and drain moisture from the cool subsoil; but we perceive within the last few years a departure from the legitimate use of this implement, which quite does away with any advantages it may really possess over its old fashioned rival. We allude to the practice of plunging the drill into the ground at a sharp angle, or far out of the perpendicular, then leaning it backwards and forwards to extricate and break it out of its position, whereby a very shallow bed only can be obtained in the loosened earth for a ridiculously short plant. This careless and slovenly manner of using a really valuable instrument reduces it certainly to a minimum.

We have heard more than one planter mention what we have ourselves observed, viz.:—that the growth of the canes for the past six months has been by no means in proportion to the amount of moisture, and as the season was particularly deficient in electricity, we look upon the observation as at least curious, leading us to inquire how far we may attribute the fact noticed to the absence of those formations of ammonia so stimulating to vegetation, and so constantly attending thunder showers.

The present has been a fair season for testing the improved state of Antiguan agriculture; for notwithstanding the incessant showers, we hardly noticed a blade of grass, either in the growing fields or in the numberless acres of prepared land. This, in a great measure, if not entirely due to the system of farming and draining now universally adopted throughout the island, and contrasts favorably with what we know, would have been the state of things under similar circumstances only ten years ago.

The very fine clean appearance of our land, with the full wide bank, deep hole, and heavy bar, shows the rapid onward strides field operations have lately taken; and it is pleasant to look back a few years, when we can remember, that even on the highest cultivated estates at this season, preparation would only be about half advanced. Such a condition now would be exceptional, indeed, a glance exhibits the lengthened fallow and the high standard agriculture has attained.

We do not, however, think these improvements due to steam machinery alone, but rather to that force in conjunction with farming. The former, by enabling the crops to be quickly reaped, allows time to be devoted to the preparation of the land; whilst the latter, calling into existence a class adapted only to lighter duties, has to such an extent economized labour, that the able-bodied, who under the old *régime* would have been fully occupied in weeding in large gangs, are now more profitably and suitably utilized to the purposes of manufacture.

We attribute, then, with good reason, any perfection achieved, or success with which we have been crowned, almost solely to the system of farming; it is not only the greatest improvement ever introduced, but we go so far as to believe, by supplying the place of a full labour market our continued existence as a sugar growing colony depended upon its introduction; in fact, it was the straw at which the sinking planter caught, and it has kept him not only floating, but brought his fields to a perfection that must unquestionably stamp Antiguan husbandry as the acme of tropical agriculture.

The present yam crop we fear must prove a failure; but our forefathers consoled themselves under similar circumstances by the following couplet, composed probably by their united efforts in a weak and poetic moment:—

"Fine canes you want, much rain must be;
But canes when fine, no yams you see."

To which we might add:

"For mud and yams they don't agree."

The red yam is without doubt the sort most likely to do well for a succession of years, and as the peculiar time of planting this variety would be about the month of August, when we usually have rain, the certainty of establishing would be nearly always secured; besides being easily preserved and less liable to decay when stored, it is a kind which we think ought to be more cultivated.

Guinea corn appears to have been extensively planted, and has succeeded well; the grain, although now ripening rapidly, is not yet dry enough for storing, like seed crops in general. Guinea corn is most uncertain, and liable to be destroyed by the large black ant which infests our fields in dry weather. To insure, therefore, the germination of the seed, the old plan of a few hours, soaking in water, to which aloes or common building lime has been added, we have found beneficial.

We consider, on good land, the end of September to be quite early enough for planting Guinea corn. If put in earlier it usually runs up to a length easily acted upon, and "lodged" by the high January winds, besides entailing the inconvenience and waste which must necessarily attend reaping from an overgrown stalk.

As soon as the plants are two feet high, they should be thinned out so as to secure only the maturity of about four stalks in each hole; for if this be not attended to carefully and early, the bunches will attain a crowded condition incompatible with the production of heavy ears. It is necessary to store before the ears are quite dry, otherwise the grain becomes easily detached and falls out unperceived. Some planters, who invariable store corn early, to prevent loss from manipulation, consider it necessary either to spread the ears evenly and thinly in a floored room, or (where space will not admit) at once to pack closely, keeping the heap so packed quite undisturbed until the mass becomes dry by its own generated heat. In adopting this self drying process we must, however, be particular that the corn is never disturbed or moved in any way after it has once been packed, and, in fact, not until we are quite sure from the reduced temperature that the whole mass is dry and fit for use.

We mark with pleasure, just at this moment, a plentiful supply of native provisions in our market. The poor have, therefore, been temporarily relieved; but we must anticipate a recurrence of those scenes of privation and want witnessed in the past year, unless a more general determination for provision planting becomes quickly developed.

We call attention to the remarkable discovery recently made by our Magistrates in reference to the law for the punishment of cane stealing, which must tend in a great measure to prevent redress being sought under that Act. We cite as an example, one estate in our parish alone which in accession to the value of stolen canes recently lost fifteen shillings by so prosecuting. The parties summoned were convicted and fined, in addition to costs, but naturally unable or unwilling to pay anything were sent to jail, which it would appear entitles the prosecutor to be at once mulcted in expenses, even if the culprit afterwards effects at any period of his incarceration to be discharged from the imposed fine.

We enquire in our ignorance, whether it would not be cheaper to bear in silence and resignation the first loss of the stolen canes, rather that gratuitously augment the injury by adding the cost of complaint, and we enquire further for the wisdom of a decision which so evidently places a penalty both on the complainant and defendant.

In review of the past month, with the present condition of the crop, and the almost certainty of our annual dry season, we are inclined to look for good returns only in particular districts and on particular estates.

With heavy showers, however, to the end of February, the Island may yet reach its average shipment, but we, nevertheless, anticipate general disappointment in the ratoon fields, which, although green and vigorous, are by no means so full as usual.—*Antigua Times.*

## GREENOCK SUGAR REFINERS.

There have been until within the past few days, twelve sugar refineries in operation in Greenock, and there are three in the course of construction. Of the latter, the magnificent refinery being erected by Messrs. Alexander Scott & Sons, on the site of the old house of Messrs. Anderson, Orr & Co., is the nearest to completion, and will probably begin melting in about two months. Of the other two refineries building, which are on an equally vast and splendid scale, it is impossible to state with any degree of certainty when they may be ready, although probably in about twelve months we shall find them both in active operation. The following are the names of the various refining firms, and average weekly out-put. In the case of the three uncompleted refineries, the lowest probable estimate of out-put is given. The total out-put is now reduced, in consequence of the unfortunate occurrence of fire on the premises of Messrs. John Walker & Co., an event which took place on the 25th ult.

| | Average Weekly Out-put. |
|---|---|
| Alexander Anderson & Sons | 300 tons. |
| Ballantine & Rowan | 280 ,, |
| Blair, Reed & Steel | 500 ,, |
| Cartsburn Sugar Refining Co. | 150 ,, |
| Crahall, Allison & Co. | 300 ,, |
| D. & J. Gibb | 180 ,, |
| Glebe Sugar Refining Co. | 750 ,, |
| Neill, Dempster & Neill | 330 ,, |
| Archibald Patten & Co. | 230 ,, |
| Paul, Sword & Co. | 250 ,, |
| Alexander Scott & Sons | 450 ,, |
| John Walker & Co. | 800 ,, |
| **Building:—** | 4,520 tons. |
| Clyde Sugar Refining Co. | 500 tons. |
| James Richardson & Co. | 500 ,, |
| Alexander Scott & Sons (Refinery No. 2) | 500 ,, |

*From the Greenock Sugar Trade Review.*

# ON THE ACTION OF ANIMAL CHARCOAL.

## REFUTATION OF MR. WERNEKINK'S THEORY.

By Dr. Kohlrausch.

In an article published by Mr. Wernekink, in the *Zeitschrift* * (1872, page 94), the author reproaches practical men engaged in the manufacture of sugar, with being far from having a precise and clear idea of the mode of action of animal charcoal. He adds that there is no established science, nor complete theory of the phenomena of filtration by charcoal published. Without troubling ourselves further with the objurgations of Mr. Wernekink, we will refer to the answer of Mr. Scheibler (*Zeitschrift*, p. 101), which reduces his assertions to their just merit.

In fact, Mr. Scheibler shows by experiments made in the laboratory of the Association, that the hypothesis of Mr. Wernekink and his pretended "theory" are devoid of all scientific basis, so far as they relate to the phenomenon of absorption of lime by condensed carbonic acid, and to the phenomenon of decoloration by ozonized oxygen.

With reference to the decolorisation of the juices, considered by Mr. Wernekink as a simple bleaching, analogous to that of tissue, since he supposes that under the influence of the oxygen of the air condensed in the char, the vegetable coloring matters which are easier to attack than the sugar, are oxydised or decomposed, that is to say, eliminated;—it will be sufficient to cite the following experiment:—

We have mixed 100 c.c. of ammonia with 66 grammes of new char, and let it stand for twenty-four hours. Then being filtered and brought to 100 c.c., the liquor was examined in Stammer's colorimetre; but although the tint was decidedly yellow, the colour was so slight that it could not be measured.

We then made a solution of 1 gramme of molasses in 100 c.c. of distilled water: the liquor indicated 14 m.m. by the colorimetre, corresponding to 7·14 of colour. These figures established, we proceeded at once with our experiment. We weighed 66 grammes of the same animal charcoal, and added the 100° c.c. of molasses solution; the liquor after standing twenty-four hours, was filtered, and brought to 250° c.c. On comparing the liquor with the semi-normal tint of the colorimetre, the height indicated was 200 m.m., or, $\frac{2 \times 200}{25} = 160$ m.m. of the normal tint, the corresponding colour is expressed by 0·63.

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* *Zeitschrift des Vereins für Rübenzucker—Indutsrie, in Oestereich.*

We then treated the char, three different times, twenty-four hours each time, with 100° c.c. of ammonia, always bringing the filtered liquor up to 250° c.c. Comparing the first and second operation with the normal tint, and the third with the semi-normal tint, we obtained the following results:—

I. = 80 m.m., and for 100 c.c. = 32 m.m.; corresponding colour 3·13
II. = 101 m.m., „ 100 c.c. = 40 m.m.; „ „ 2·50
III. = 334 m.m., „ 100 c.c. = 134 m.m.; „ „ 0·74

Total colour regained...... 6·37

The total colour of the molasses solution is given above as 7·14. Now, the char not having absorbed 0·63, had therefore retained 6·51, consequently the amount of the coloring matter absorbed by amomnia being 6·37, we have got back 98 per cent. of the colouring matter abstracted by the char from the molasses solution. We think that these figures will suffice to close against the arguments of Mr. Wernekink; even the little door of escape left open by Mr. Scheibler, by his saying (ironically, no doubt), that perhaps the coloring matters in the molasses solution might be collected in their nascent state, by heating the char with a current of hydrogen.

Whatever may be Scheibler's phenomenon of decolorisation by calcination in a current of hydrogen, we have certainly not met with any bleaching phenomenon in all our experience with animal char, and we believe, we may affirm, that such a phenomenon seldom or never takes place in these conditions, but that the coloring matters are absorbed by surface attraction, which indeed is a well known quality possessed by char, in common with many other organic and inorganic substances, such as pumice-stone, albumen, hydrated oxide of iron, vegetable charcoal, &c. Lastly, we must now refute the assertion of Mr. Wernekink, that ammonia and its salts, substances now-a-days so important to the artificial manure manufacturer, can be obtained at a very low price by passing a current of steam through calcined char.

Mr. Wernekink comes to this conclusion by supposing that the formation of free nitrogen takes place in the pores of the char, at the expense of the atmospheric air. This nitrogen, in the presence of steam, would form ammonia, of which one part would combine with the carbonic acid of the char, and the other part would be carried away by the steam current.

In support of his opinion, Mr. Wernekink is satisfied with stating, that no one has as yet practically succeeded in entirely exhausting the source of ammonia by treatment with steam. Further, he says, there has been no analysis made with the object of determining the ammonia escaping from the filters, treated by steam. Lastly, he pretends that the quantity of ammonia is "evidently" too considerable to justify in the least the hypothesis, that it is derived from the combustion of nitrogenous substances, and he adds, that this is so much more "true," when we consider that in the revivification of the char, these substances are as much as possible eliminated before calcination, either by alkaline treatment, by fermentation, or by washing, &c.

Although such a demonstration is very unlikely to attract the attention of competent persons, inasmuch as practically negative results, or the absence of analytical data, cannot be taken as argument in favour of a hypothesis, nevertheless we thought it our duty to discuss these assertions, point for point, upon the ground of analysis, in order to prevent similar ideas taking root in the sugar industry.

To show that the ammonia produced during the treatment by steam is not of atmospheric origin, but resulting from the nitrogen contained in the residues of nitrogenous combustion, we have made the following experiments: we heated a certain quantity of good new char, containing 7·66 per cent. of carbon, with a mixture of lime and soda, which gave 1·2738 of nitrogen.

We then calcined in a closed vessel, a sufficient quantity of this char for our experiment. The experiment finished, we spread out the residue of the calcination upon a large surface, to allow it to absorb as much atmospheric air as possible, and we may as well here state, that while emptying the apparatus, we have perceived a strong odour of ammonia and of cyanic compounds. We then determined the quantity of nitrogen by estimation of the ammonia. The char dried and recalcined was again analysed for nitrogen and ammonia, and the determinations continued in this manner, till it was impossible to obtain any further indication of their presence.

As was stated above, the determination of nitrogen was made by heating the char in a tube with lime and soda, and by collecting the gas in sulphuric acid. The determination of the ready-formed ammonia was obtained in the following manner:—

We placed 120 grammes of char, free from dust, in a conical shaped glass vessel (of 50 m.m. diameter at its base, and 8 m.m. at its apex), provided at the upper part with a perforated cork to receive a glass tube connected with a globe of water to produce steam. The lower part of this conical vessel was hermetically connected with a Woolf's bottle, half filled with caustic lime, and the second tube of the bottle communicated with a receiver. This tube was 70 m.m. in length, in order to condense as much as possible the vapour passing through it, and to avoid too great an accumulation of liquid in the receiver: the latter was provided with an aspirator. Having brought the water in the globe to the boiling point, we opened the tap of the aspirator, allowing the water to flow from it sufficiently slowly to be able to count the bubbles produced in the receiver.

The steam then passed through the char, and carried with it a part of the ammonia in a gaseous state, and partially condenses itself on the caustic lime, but it soon becomes free again, and condenses in the sulphuric acid in the receiver. In every experiment the aspiration was continued four hours, although we had ascertained from previous experiments, that after the third hour there was no more acid neutralised by ammonia. After having well washed the tube of communication, and added the washings to the contents of the receiver, we have determined the ammonia by a ten per cent. solution of potash.

We give here the results of the determinations of ammonia and nitrogen:

| | Carbon.<br>Per cent. | Ammonia.<br>Per cent. | Nitrogen.<br>Per cent. |
|---|---|---|---|
| New Char | 7·66 | — | 1·269 |
| 1. First calcination | — | — | 1·200 |
| 2. First steam treatment | — | 0·0173 | — |
| 3. Second calcination | — | — | 1·200 |
| 4. Second steam treatment | — | 0·0144 | — |
| 5. Third calcination | 5·28 | — | 1·029 |
| 6. Third steam treatment | — | 0·0061 | — |
| 7. Fourth calcination | — | — | 0·977 |
| 8. Fourth steam treatment | — | 0·0091 | — |
| 9. Fifth calcination | 2·99 | — | 0·807 |
| 10. Fifth steam treatment | — | 0·0018 | — |
| 11. Sixth calcination | — | — | 0·780 |
| 12. Sixth steam treatment | — | 0·0010 | — |
| 13. Seventh calcination | 2·09 | — | 0·539 |
| 14. Seventh steam treatment | — | — | — |

These figures speak for themselves, and do not require further demonstration.

The first column shows, as will be easily understood, the increased diminution of carbon, according to the different calcinations; the third column, the decrease of the figure for nitrogen with that for the carbon from 1·269 to 0·539; and the second column shows the diminution of ammonia with that of the nitrogen. The latter column shows also that the matter for analysis reduced to 80 grammes, did not allow of the further quantitative determination of the ammonia, in the moment the nitrogen fell to 42·5 per cent from its primitive proportion. If, after the experiment of No. 13, we had reduced the char to a fine powder, and then submitted it to a strong calcination, and supposing we had operated, for instance, upon 200 grammes, we would no doubt have succeeded in making further determinations of ammonia, but what is beyond a doubt, that in proportion to the increase of the minimum of nitrogen, we would not have found a trace of ammonia.

We had thought, in starting, that the quantity of nitrogen obtained in the first discharge, and the nitrogen contained in the char, after the second calcination, would represent the total of nitrogen found after the first calcination, but the loss in nitrogen gas observed during the discharge and cooling in the air of the residue is too manifest. The char indicating 1·200 nitrogen after the first calcination, and the amount of the two following operations increasing to 1·137, there was consequently a loss of nitrogen = 0·063, during the calcination. As to the question of knowing if the char retains, similar to the soil, small quantities of ammonia, inextricable by steam, we leave it undecided, without considering it possible.

(*To be continued.*)

Escudier Evaporator and Croncher Mill.—We learn that Mr. Etienne Menard, of Indian Bend, parish of St. Mary, has this year again succeeded well with the No. 2 Croncher mill and the Escudier evaporator. He had 42 arpents of cane to roll, which kept his mill running forty days, and turned out 48 hogsheads of sugar. He made just twice as much sugar as last year, and from experience, operated his machinery much more successfully. He made better and drier bagasse by removing nearly all of the rubber wedges on the bagasse side, and replacing them with wooden ones. Planters who use these mills should make a note of this. His Escudier evaporator gave excellent results, and his experience with it, for two years in succession, will do much to bring it into favourable notice. Mr. Menard is one of the best and most successful planters in this section.—*The Louisiana Sugar Bowl.*

# IMPROVED METHODS OF SUGAR CULTIVATION IN JAMAICA.

### By Mr. Charles Melville.

There can be no doubt that mountain estates in Jamaica, possessing those necessary qualifications, a seasonable climate, and a fertile soil, should prove highly remunerative. The causes of their having failed to prove so, to the extent anticipated by over sanguine proprietors, may be briefly summed up as follows:—

1st. Large losses of stock (cattle and mules).

2nd. Loss from canes having been planted and brought to maturity and allowed to rot.

3rd. Small yield per acre of lands, especially clay hills.

4th. Large expenditure, in consequence of the expensive system of agriculture used—labour being scarce and dear.

5th. Loss of molasses on voyage home, or say—

6th. Inferior quality of sugar made.

Possible cures will be suggested for these evils—

First, loss of stock arises principally from the harassing nature of the work expected from the cattle in the cartage of canes to the mill; the shocks and strains which an animal receives in its progress from a distant hill side piece to the cane yard, being of itself a cause sufficient to account for the rapidity with which they lose condition, pine away, and die. The only remedy for this state of affairs under the present system of carriage, is a largely increased herd of stock, several good pastures where a sick or tired animal may recruit its strength, and a very extensive and complete system of hard and smooth roads. In my opinion, the carriage of canes by cattle, with the ordinary wains and carts, is a wasteful and inefficient system, and should by no means be allowed to continue, when a less expensive and much more efficient means exists, devised, constructed, and adopted by scientific, practical men, and which has been found to succeed for a number of purposes similar, if not identical with, the carriage of canes. I refer to tramways, and will speak more at length on the relative merits of the two systems of transport, when considering the subject of tramways as the chief means of preventing loss under this head. Another cause of the loss of stocks is disease, which may, and in all probability will occur at intervals, and which no human foresight can prevent from possibly destroying the whole herd of stock. I would especially direct the attention of the planters of this island to this fact, that disease has appeared among our cattle, and would earnestly beg them not to shut their eyes to the fact, blindly; and supposing that they alone will escape the scourge that has of late years decimated the herds of almost every civilized land.

Secondly, loss arising from canes having been planted and brought to maturity, and allowed to rot.

In many instances this arises from inefficient machinery, but the cure for it is evident; but the greatest and most serious losses under this head arise from the inability of the cattle to bring the canes quickly enough to the mill; this will also be more fully treated further on.

Thirdly, loss arising from the small return of lands.

Under this head, we shall have to consider the whole system of preparation of land and tillage, for principally on account of an imperfect system does the loss under this head arise; and this is more especially the case with respect to a large portion of the lands on hill side estates in this island consisting, as for the most part they do, of stiff clay, naturally fertile, and abounding in both the organic and inorganic substances required by the cane as food. But the word stiff describes the reason of their present unproductive state, and the great difficulty of growing a ratoon on them. These lands are impervious equally to the roots of the canes, to the sun, air, and rain, and the consequence is, that after the small portion of land that has been turned over by the hoe of the cane hole digger has been exhausted of its supplies of nutriment by the plant, and again consolidated by being left for 21 months untouched by any implement but the weeder's hoe, the roots of the cane being checked in their search after the food locked up in the solid land, the plant languishes, and even with the use of stimulating manures, can only be made to produce a scanty stole of miserable canes.

The impossibilities of properly tilling under present circumstances, arises from the fact that, the cattle which should be used for this purpose are worn out in the cartage of thousands of tons of canes to the mill, and are with difficulty, and only with great loss, able to accomplish this. One other reason of small returns which applies more to the flat and more friable lands, arises from the existence of a blight or insect, which attacks the roots of the plants; and as their existence and mode of attack seems to be almost unknown, and certainly is unnoticed in the island. I now describe what, from continued observation and experiment, I conceive to be the manner in which this insect insiduously destroys our crops.

Commonly known by the name of the "cane louse," this insect, which is of the class *Aphis* in its developed state *as a louse,* very much resembles the cochineal, is of a light pink colour, and covered with a fine, white, furry substance, which seems to be secreted by the insect, from whose bodies it is scraped and collected by the ants, who, it is well known, feed on the secretions of this class of insects. From a louse it developes into a fly, and deposits its eggs upon the upper surface of the cane blade, from whence they are washed by the rains, and deposited around each joint of the cane, where they may be discovered as a light pink powder easily confounded with the wax which exists in this part of the plant. When a top containing these eggs is planted in a light open soil, when the rays of the sun act as a universal mother, they are hatched, and the young insect being placed by nature in the most favourable position, seizes upon the young roots as they issue from the joint, feeds upon them, fattens, and kills the plant which withers up, and on being pulled from the earth may be seen surrounded by its destroyers, and with all its young roots eaten off. I am at a loss to characterize these insects; in almost every particular they agree with the "*Cocidæ*" *Aphilles Ordes Homophria*, but the females are not apterous, as they do as I relate above, assume wings, and deposit their eggs in positions quite unattainable by wingless insects.

The stiff clays are less liable to the attacks of this insect, as from the causes above stated, they are less favourable to the development of organic life, whether animal or vegetable. I believe, from observation, that the louse becomes fully developed in the end of May, and that the female assumes wings and deposits her eggs during the summer months of July, August, and September, and that these eggs are again hatched about December or January; consequently canes which are planted before the end of May, and late in the fall, will be safe from the attack of this insect, for at these seasons the insect has left the joint of the cane and has not yet commenced to deposit eggs, therefore the tops planted are free from blight or ova. The eggs will, it is true, be deposited upon the leaves of the growing plant, and as I have before described, lodged round the joints, there to hatch, but in this position they do no harm to the plant, the louse being unable to pierce the rind of the cane, and not possessing sufficient locomotive power to reach the roots. If the upper joints of canes are examined in the months of June, July, and September, the full-grown louse will be found, but the plant will be healthy, as the roots are safe. The object then is to plant a top free from the egg, and this may be accomplished, as before stated, from the end of September to the end of May, as this includes the time after the last deposit of eggs in September, and before the first deposit in May.

Fourthly, losses by excessive expenditure.

On this head, it is sufficient to remark that the whole culture of the estate, from the cutting of the top to the reaping of the ripe canes, is performed by manual labour alone, and this in a country where labour of this sort is proverbially dear and difficult to obtain. This system alone, so long as it is persevered in, will, no doubt, lead to the continued abandonment of sugar estates, unless it is supposed that sugar will always command a price relatively very much higher than any other crop produced from like areas of land in any known part of the world.

5th. Loss of molasses on the voyage home.

The means of preventing this loss is well known.

6th. Inferior quality of produce made.

The same remark applies to this head.

Having briefly noted what I imagine to be the chief causes of loss, in the working of this and similarly situated estates, I will now mention what I imagine to be the rational means of cure, and in stating the conclusions which I have arrived after much thought and some study of the subject, though I am still open to conviction; I am decided by prejudice in favour of those views on the subject of agricultural management, advocated and practiced by eminent authorities in other sugar producing colonies, and to some extent in this Island.

With respect to the means to be adopted to prevent loss under the first head, viz., of Stock, from their being employed in the arduous task of carting canes to the mill, over rough or muddy and steep roads. I have already stated that I believe tramways laid through the estate to the mill, will be found a far more desirable mode of transport, but we will now proceed to compare the two systems, and to examine their relative merits. With cattle and wains an extensive system of roads has to be kept in good repair, and this very often in parts of the country where rain falls in abundance, and which is liable to heavy floods at two seasons of the year, the destructive effects of which, upon roads however well made and maintained, need not be enlarged upon.

When to this is added the fact that a large portion of the land of these estates are hilly and composed of stiff clay, and where the material for the making of the roads has to be carted from some distance, and which material has to be renewed every two or three years, in consequence of the old roads sinking into the yeilding substratum; (this process being materially assisted by the unavoidable traffic over the roads in wet seasons, to the manifest injury of vehicles, stock, and roads themselves.)

It will be seen that this item of expenditure must be heavy, if the roads are to be maintained in anything like fair order.

The keeping of the vehicles in repair is a matter of no trifling cost, the constant repairs to wheels forming a large part of the regular carpenter's bill.

The absolute necessity of having at command a considerable class of what may be called, in a certain sense, skilled labour, for the ordinary creole labourer cannot, and in fact will not, undertake the working of our cattle, and the coolie has been found wanting in the physical strength and endurance necessary to control the steers, when carrying heavy loads over rugged ground; bearing in mind also, that it is becoming more and more difficult every day to procure in this, as in other branches of the labour supply, people who have undergone the necessary training, to fit them for the proper management of stock, under the difficulties to be encountered in these mountainous parts. Remembering also with respect to the character of the roads over which these loads have to be drawn, that a large per centage of the deaths which occur, arise from accidents when the cattle are descending the hills, when it is almost impossible should they fall, to prevent them being dragged some distance ere the wain can be arrested.

Their liability to fall being made (apparently with a purpose) as great as possible, by the whole weight being thrown on the necks of two steers. Finally, observing from past experience that this system, without a largely increased herd of stock already too unweildy, is quite inadequate to the task of reaping the crops in time to prevent loss by rotting, leaving out of consideration the losses likely to occur from disease, which is becoming prevalent in all parts of the world.

I think this system can hardly be called an economical one, and it certainly is a cruel, troublesome, and inefficient one at the best.

*(To be continued.)*

The *Greenock Sugar Trade Review* of Wednesday, 19th March, announces that the refinery of Messrs. John Walker & Co., recently destroyed by fire, is to be speedily reconstructed. It understands that arrangements are nearly completed whereby the building of a new house will be proceeded with. The house will be differently constructed from its predecessor, and of greater capacity, as it is intended to turn out about one thousand tons per week. This gives us the prospect of a considerable increase of Greenock refined in the market; but several months must elapse ere the work is accomplished.

# THE YIELD OF THE NEW DUTIES IN FRANCE.

From the *Revue Politique et Littéraire.*

(Concluded from page 153.)

## LAWS OF 1851, 1852, AND 1856.

### THE DRAWBACK AND THE ATTEMPTED EXPORTATION OF BEETROOT.

But scarcely had this equality been established between the two sugars, when the revolution in February 1848, and its immediate consequence, the abolition of slavery in the colonies, upset all the conditions of industry, and caused a considerable rise in the price of labour. New claims, on the ground of the abolition of slavery and the distance of the French market, the only one where the colonial treaty permitted them to sell their product were made by the planters to obtain (this time under the shape of a tax) a protection against the beet-root sugar.

In 1851 the Government brought before the National Assembly a project of law, dealing with these demands in a manner well calculated to pacify the complaints of the planters; it proposed a considerable reduction in the duty, and at the same time reorganized, upon a new basis, the system of collecting the same. At last the old system, the existence of which, its primitive and long forgotten character of the *dues of the posessions of the West* alone could explain without justifying it, was relinquished, and the tax was paid not on the supposed yield of the raw, but on the refined sugar itself; the presumption disappeared to make room for an easily ascertainable reality.

This is the system known as *duty on consumption*, because the tax is levied only at the moment when the merchandise possesses all the qualities required by the consumer, and is delivered to the grocer to be retailed to the public. The natural consequence of this change was that the ordinary refiners became subjected to Government inspection, as had been the case with the manufacturers and manufacturing refiners. [In other words the sugar was to be refined in bond.]

From this time forth it was officially admitted, that the legal return required from the raw sugar, was frequently inferior to the yield actually obtained by the refiner. For instance, the amount of the latter might be 75 per cent. instead of 70 per cent. Now, since the refiner had paid duty only on the 70 per cent. there remained in his hands 5 per cent on which no duty had been charged, and which, nevertheless, was sold at the same price as the rest. By levying the duty upon the actual yield ascertained, the Customs would have put a stop to the advantages which the refiners are in a position to derive, and which they eagerly watch for, as constituting a principal source of their profits.

If these new principles had been carried out, the duty upon sugar would have been established upon a sound and definite basis, the natural and unfettered state of the industry would have been no longer complicated by fiscal elements, and the exchequer would have no longer had to fear in every scientific advance the origin of some new fraud leading to an unexpected deficit in the returns of duty.

The law was indeed voted on the 13th of June, 1851, to come into operation at the beginning of 1852; but several ministerial changes following in rapid succession, delayed the preparatory measures needful to its being put into execution, and the National Assembly was taken by surprise by the *coup d'état* of the 2nd December, before it could send forth its work into the domain of commerce.

The law of the 13th of June 1851, and the duty on consumption vanished together. The dictatorial decree of the 27th March 1852, retained the tax on colonial sugar, which was only to have lasted a few years, but which was prolonged at different times along with divers other taxes until the 1st January 1870. The disturbing effect upon commerce by the abolition of slavery was however not everywhere so deep, nor so lasting as had been represented. The Island of Bourbon, for instance, had quietly attained its production of 1847, even before it was assisted by the colonial drawback. Moreover the decree of the 11th of July 1861, the natural result of the famous treaty which introduced into our laws the free-trade system, entirely removed the *raison d'être* for a drawback on colonial sugar, by destroying the colonial treaty which required the colonists to sell their sugar in France. As soon as they had obtained their freedom and were on an equal footing with the mother country, they had no plea to ask for protection against the beet-sugar manufacture, because it was then open to them to sell in foreign markets, and thus to escape from the competition of the French producers. But, as the colonial drawback has been finally abolished, and there is no question of re-establishing it, we shall not insist upon the obstacles which it necessarily opposed to the development of the beet-root manufacture.

This industry proves the truth of the saying, that a cause is only strengthened by opposition; it gave one of the best examples of the success of free-trade policy, in that the effect of competition has been to make it thrive even in proportion to the obstacles it has had to overcome.

From the first year of the second empire, although the indigenous production was then far from having attained the development which it now presents, it had been contemplated to push beet-root sugar into foreign markets, that the number of its buyers might be increased, that thus, by their competition amongst themselves, the maintenance of a remunerative price should be insured. But exportation was barred by the construction of the tariff, in fact raw beet sugar was liable to duty immediately on leaving the place of manufacture or the bonded warehouse, and if the refiner desired to export it after being refined, he did not receive back the duty on consumption which he had paid. As this duty of twenty-two shillings per cwt. was nearly equal to the amount of the taxed sugar, it is readily conceivable that he could not present himself in foreign markets where he would have also to bear the foreign duty.

It is true a former decision of the Minister of Finance, of the 1st December 1846, had authorised the exportation of raw-beet sugar free of duty. But foreign commerce could not trust to a single decision, liable at any time to be revoked, so as to enter into contracts; moreover, what the customs accepted as raw sugar, was dry sugar of very high saccharine strength, and the processes then in existence did not admit of the production of large quantities. These qualities were, moreover, at a premium with the French refiner, in consequence of the considerable profits which the difference between its real and legal yield allowed him to make by the duty, always calculated on the theoretical system. There was therefore no encouragement for exportation, and it was in fact impracticable, so long as refined sugar could not be sent out of the country without paying the French duty.

The colonial raw sugars, on the other hand, could be placed upon foreign markets, after having been refined in France. On entering they paid the duty of their legal yield, viz.: 70 per cent. on the gross weight; on leaving, the Excise returned to the refiner for every 70 pounds of refined sugar exported, the tax levied upon 100 pounds of raw sugar; this is what is called the *drawback*, a general institution brought about in the interest of national labour to correct the effects of taxes on consumption, which would not allow of an article being manufactured in one country intended for exportation into another. But these 100 pounds of raw sugar had in reality furnished 75 to 80 pounds of refined sugar to the refiner. Consequently the Treasury allowed him by the drawback from 8 to 13 per cent. more than had been paid, the result being a veritable premium paid by the Treasury on exportation, for the benefit of refined sugar of colonial origin.

The law of the 28th June 1856 sought to abolish this abuse by raising the legal yield from 70 to 75 per cent. The beet-root sugar manufacturers took advantage of this circumstance, asking the same right of exportation with the drawback on refined sugar, and even offering to be assessed at a higher legal yield—for instance 80 per cent.—by which it would not have been easily possible to obtain as the colonial sugar did, the disguised export premium. The Government remained inexorable. It recognised perfectly that the drawback would always constitute a loss to the Treasury, and in submitting to this loss on colonial sugar, it was in consideration of the gains resulting therefrom to the mercantile marine. In what manner could it more distinctly acknowledge the bad assessment of the duty? However, the Government did not trouble itself in the least to modify this by returning to the principles of the republican law of 1851, confiscated with the public liberties by the *coup d'état* of the 2nd December.

## LAW OF 1860.—FREE TRADE AND THE SUGAR DUTIES.

### THE UNIFORM TYPE.

The free-trade revolution form of 1860 has now arrived. To aid the French industry to sustain the foreign competition, Government promised to establish railways, canals, and the reduction of taxes. In this plan of reform, the interests of sugar were not forgotten. Since the original law of indirect taxation of the 28th April 1816, the duty on sugar had been stationary at 18/3 per cwt. upon the highest class, which amounted to 21/11 with the two-tenths then in force. The law of the 23rd of May 1860 reduced this tax to, including the tenth, 12/2 or nearly one-half. With a view of stimulating the industry, to perfect itself, it was decided that all raw sugars should be charged with the same amount of duty, whatever their yield in saccharine matter. Government went even further, by offering an arrangement which fixed for the juice of the beet-root a legal yield, calculated by the density of the juice, leaving in the hands of the manufacturer, free of duty, all that he could obtain beyond the legal taxation.

The drawback was maintained to the advantage of the colonial and foreign sugar, with the elevation of the legal yield to 76 per cent. on the raw sugar (later, it was raised to 79 per cent., by the law of the 16th May, 1863). In vain the beet-root sugar manufacturers endeavoured to obtain the same advantage, although to that effect they had offered to accept a legal yield of 85 per cent. and one-fifth.* But although refused to the native producers, their indirect benefits from the drawback were nevertheless great, and increased with every progress in the industry raising the real yield, because the advantage is represented by the surplus above the legal yield, which surplus ought to have paid the duty; lastly, it increased also with the rate of duty, so that foreign sugar, charged with a surtax of 2s. per cwt., obtained an advantage therefrom, which gave it a preference over French colonial sugar.

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* A difference in the legal yield between the two sugars was moreover very justifiable, for the proportion of saccharine in the raw beetroot sugar is generally higher than that of the colonial raw sugar of equal appearance.

Soon after, even before the reduction could produce its natural effects to the benefit of the consumer, the war with Mexico necessitated the increase of the duty, from 12s. 2d. to 17s. 1d. per cwt., which again augmented the advantages of the drawback, whilst at the same time it injured the Treasury; this advantage from the drawback occasioned a great injury to the beet-root industry, by the fact that their competitors were the only ones to profit by it, whereby their sugars were at a premium with the refiners, and, in consequence, the price of beet sugar was lowered.

Exportation was becoming, therefore, a most pressing necessity for the beet-root; moreover, owing to its production constantly increasing, it now considerably surpassed that of the colonies, and the home market already overstocked, and the only one available to the beet-root, threatened no longer to afford an adequate outlet.

Since 1856, the united colonial and indigenous production had always exceeded the French consumption; in 1856, by 25,000 tons; in 1857, by 35,000 tons; in 1858, by 67,000 tons; and in 1859, by 61,000 tons, &c.

Lastly, the innovations of the law of the 23rd May, 1860, were not favourable to all the producers of beet sugar. The system suited those in the departments of the Oise and Aisne, working with beet-root very rich in sugar, but not those in the departments of the North and the Pas-de-Calais where the root does not possess such high saccharine contents. The uniform standard on which the duty was based, gave advantage to those who manufactured very pure white sugars, and their industry very soon developed itself with the greatest energy in this direction of progress. But every one could not follow this progressive movement, because it required a very extensive outlay for an entire change in the plant, and those who continued to make inferior *cassonades* were therefore crushed by this uniform duty.

### LAW OF 1864.—TEMPORARY ADMISSION AND THE COLOGNE YIELDS.

The result of all these complaints was the law of the 7th May, 1864, which stands good up to the present time. It placed beet and colonial sugar on the same footing as far as exportation is concerned, but substituted for the drawback *régime,* which was generally admitted to be too fatal in its effects upon the Treasury, that of *temporary admission.* When a refiner intends to export, instead of paying the duty the moment the raw sugar leaves the manufactory or the bonded warehouse, he signs an engagement to export in the space of four months (reduced at present to two months) a corresponding quantity of refined sugar, or else to pay the amount of duties, if he does not within that time present *certificates of discharge* covering the required quantities. The temporary admission is, therefore, a simple suspension of payment of duty, which now no longer subjects the Treasury to the inconvenience of suddenly refunding payments which it had received, as was the case under the *régime* of drawback.

But the great change introduced by the law of 1864, in the reestablishing of the several types for the assessment of duty was a measure followed of course by the suppression of the premium on fine sugar. Since the impurities in the sugar have the effect of making it yellow, a *gradation of colour* more or less dark, for raw sugar or *cassonades* may serve as a criterion of its saccharine richness. In accordance with these facts, the Dutch have established a series of twenty types or samples carefully graduated, with which are to be compared the sugars intended for sale; the colour decreases with the rise of the numbers in such a manner, that number 20 represents the whitest, consequently the purest *cassonade.*

The gradation is made use of to determine four categories of sugar, charged with four different duties more or less in proportion to their relative richness.

This is shown by the following table :—

| | Per cwt. |
|---|---|
| The type No. 13, and below .............. | 17/- |
| Of No. 14 to No. 20 ..................... | 17/10 |
| White raws.............................. | 18/3 |
| Refined ................................ | 19/- |

At the same time the French Government opened negotiations with England, Holland and Belgium—which, like ourselves, pay duty upon the raw sugar, in order to establish the basis for a common system affecting exportation from one country into another, that thus the bounties which arose from the existing discrepancies might be abolished. The object was to fix the average yield of sugars of each grade of colour, whereupon to base the amount of a legal yield for exportation common to the four countries.

By the Convention of the 8th November, 1864, a Special Commission assembled at Cologne, made experiments, which have led to the following scale being fixed, known as Cologne yields :—

| Types. | Yield per 100 lbs. |
|---|---|
| Under No. 7 ........................ | 67 lbs. |
| Nos. 7 to 10 .. ...................... | 80 ,, |
| Nos. 11 to 14 ........................ | 88 ,, |
| Nos. 15 to 18 ........................ | 94 ,, |

This is the *régime* which has been in force for eight years. What have been its effects?

The type No. 13 is equal to what was formerly called *a good fourth*, [*bonne quatrième*] it is an average quality, and embraced by far the largest part of the beet-root sugar manufactured previous to 1860; above that number there were two qualities known as *belle quatrième*, and *fine quatrième*, whilst below there was *bonne ordinaire*. The organization of 1860, based upon the uniform duty, stimulated the manufacturers to produce as much as possible the two descriptions above the *bonne quatrième*, namely, those numbers above the Dutch No. 13, and to provide themselves with machinery in view of this result. The law of 1864, by re-establishing the differential duties, precisely reversed this tendency. If they could always have obtained No. 20, the surtax of 10d. per cwt. chargeable upon it, would not have deterred them; but when only No. 14 or 15 could be reached, this same surtax exceeded the extra value of the sugars indicated by these types, so No. 14 or 15 were sold for less than No. 13. This shows to what perturbations the sugar industry was constantly exposed by the duty being badly assessed, a circumstance which dominated all the combinations of the industry.

But what introduces the strangest complications, is the entire want of correlation in the Cologne yields and the duty on the divers categories of sugar according to the law of 1864. A single instance will make it easily comprehensible.

A refiner takes into his works 100 tons of sugar below No. 7; the duties of 1864 being at present augmented by five-tenths, this kind of sugar pays 25/8 per cwt., that is to say a sum of £2,552 for one hundred tons. He sells this sugar under the *régime* of temporary admission, and signs an obligation for £2,552 in case he should not show an exportation of a corresponding quantity in the space of two months. Now, according to the results of Cologne, 100 tons of sugar below No. 7 yield 67 tons of refined sugar; and it is this quantity the refiner is obliged to export to discharge his obligation of £2,552. But by consulting the tariff of 1864, we find that a hundred weight of refined sugar pays at present, with the five-tenths, a duty of 28/8. It is, therefore, with a payment of 28/8 × 20 × 67 = £1,920 that the refiner discharges his obligation of £2,552. In practice the refiner himself does not export. Any one who has sold refined sugars for exportation obtains, on passing the Customs, a certificate of exportation, which he can sell to the refiner who has a temporary admission to discharge. These certificates are bought and sold like any other commercial security, they have their quotations on the exchanges, and in the newspapers of the Northern departments, like other merchandise. At present the market price is 30/3 to 30/6 per cwt. How much has this certificate cost to him who sells it? On the duty of one hundredweight of refined sugar, that is 28/8; he makes a profit of 1/7 to 1/10; this sum represents the premium which he has gained by exporting. The loss to the Treasury is 8/2 on the 25/8 amount of duty on one cwt. of raw sugar. This 8/2 has been divided between the exporter, the refiner, and the sugar manufacturer, who sells his inferior qualities of sugar at a higher price in consequence of the fiscal profits which the refiner obtains.

### The Law of Correlation.

The article No. 4 of the Convention of the 8th November, 1864, precisely to avoid this result, provided for the establishment of an exact correlation between the duties of the divers classes of sugars and the yields, which were to be determined at Cologne. It is this provision, which comes at last, under the consideration of the National Assembly, next Monday. The Commission has confined itself to taking, for a starting point, the duty on refined sugar, and establishing for the raw sugars a definite relation to the legal yields.

| Classes. | Yield per cent. | Present Duty per cent. s. | d. | Reformed Duty per cent. s. | d. |
|---|---|---|---|---|---|
| Refined | 100 | 28 | 8 | 28 | 8 |
| Nos. 19 & 20 | 96 | 27 | 6 | 27 | 7 |
| Nos. 15 to 18 | 94 | 26 | 10 | 26 | 11 |
| Nos. 11 to 14 | 88 | 26<br>25 | 10<br>7 | 25 | 3 |
| Nos. 7 to 10 | 80 | 25 | 7 | 22 | 11 |
| Below No. 7 | 67 | 25 | 7 | 19 | 3 |

The above alterations, in short, consist in a reduction of duty on the inferior qualities, nearly in proportion to the present losses which they occasion to the Treasury by the working of the temporary admission system. A larger quantity of sugar will be taxed, but the amount of the tax will be less, and in the end the Treasury will lose more, for at present all low sugars under No. 10 are not subjected to the temporary admission.

But the Dutch standard system has moreover another disadvantage for the Exchequer; it is based upon the colours, and at present the saccharine richness bears no longer any necessary relation to the colour. Sugar below No. 7, contains sometimes 80 per cent. of sugar, and even more, instead of 67 per cent., which the experiments at Cologne admit. It is quite easy to obtain rich sugar under the low class; not to speak of the many particular processes, is it not sufficient that the sugar should be incompletely dried in the centrifugals? There will doubtless be retained a certain quantity of molasses which the machine should have extracted, and this molasses will be charged with duty; but it requires a very small quantity to darken very much the colour of sugar. As for the pretence that the Government will regulate the centrifugal process, it is, to say the least, unreasonable.

To meet a host of inconveniences, which will not fail to increase, the Government demanded the right to make a chemical or saccharimetrical analysis of sugar, whenever there was a suspicion that the colour was not in harmony with the saccharine richness. The Comission would not agree to this, which is easy to comprehend, for it would have been nothing less than the suppression of the types and their replacement by analysis. If it be desirable to introduce this new reform, it should be stated clearly, that the new objections which will result therefrom may be freely discussed.

The Commission only consents to have recourse to analysis in cases where sugars approach very nearly to the limit of a *class*, and in which their classification by colour is doubtful, that is, to recognize that analysis shall not be appealed to in cases where the colour is not doubtful. The basis of duty is not changed, and all its *faults* remain. Sugars below No. 9, which at present form so important a part of the indigenous production, are not of doubtful classification, and nevertheless have a very high saccharine content,—they will continue therefore to escape duty, to the loss to the Treasury.

### The Duty on Consumption.

There is only one remedy against deficiency and fraud, namely, one equitable tax, a *régime* capable of conforming the sugar industry to the laws of political economy, instead of allowing it to be buffeted incessantly by the caprices of the Treasury, which has ruled its entire existence; it is the duty on consumption, established upon finished refined products, when it is ready for food. In that state there is no more uncertainty about the yield, no more series of *standards*, no falsification or disguise is possible,—it is sufficient to weigh it.

What objection can there be to a system so natural and so simple? It is, that it would be requisite to supervise refineries, and it is said that this supervision is impossible, particularly for refineries in large towns surrounded by buildings, which would facilitate clandestine removal. But there are under inspection five to six hundred sugar manufactories and manufacturing refineries, some of them of considerable size, at present under supervision. The refineries proper number about thirty, and they were under the inspection of the Excise from 1853 to 1864. Therefore the thing is possible, and it will be hard to convince anyone that it is more difficult to watch sugar bags at Villette than casks of wine at Bercy.

It is also said,—and it is even the general opinion,—that the Convention of 1864, expiring in 1874, does not allow the duty to be based upon any other foundation than that of the types. But we have already in France refineries submitted to the assessment of duty on consumption, those of the manufacturing refiners. Does this prevent them exporting their productions to England, Holland or Belgium? Every one knows it to be the contrary. Why then could the system which rules them not be generalized and extended at once?

Emile Alglave.

## MEMORIAL OF THE SUGAR REFINERS OF GREAT BRITAIN AND IRELAND,

*To the Right Honourable W. E. Gladstone, First Lord of Her Majesty's Treasury.*

We give the following details, in order to show cause for the prayer of this Memorial, which is that Her Majesty's Government will make such representations to the French Government as will lead to the holding of another Conference of the four powers who are parties to the International Convention of 1864 for the regulation of drawbacks on the exportation of refined sugar, and to a delay in the progress of legislation in France on the subject until the four powers have agreed on a united course of action.

Since we addressed to you our Memorial of the sixth of May last, in which we stated in detail our reasons for asking for a revision of the Sugar Drawback Convention of 1864, great progress has been made towards the end in view. The question of refining in bond, and levying the duty on the refined sugar instead of on the raw, proposed in our memorial as being the only means of attaining the object of the Convention of 1864, was referred by the French Government to the Superior Council of Commerce. This Council commenced its consideration of the subject on the 8th of May last, and concluded it on the 25th July. It held eighteen sittings, and took the evidence of forty-two witnesses. This evidence, together with the general documents, written depositions and reports, are now published in two volumes, entitled "*Enquête sur la question de l'impôt du Sucre à la consommation.*"

The Council concludes its labours by recommending—

> "The practice of refining in bond, and the tax on the finished production as assuring with more certainty the just distribution of the tax upon sugars and its exact receipt, if this system be accepted under efficient conditions, by the powers forming part of the International Convention."

The President, M. Pouyer Quertier, in putting the question to the vote, remarked :—

> "In the enquiry made by the Commission, it has been established that the standards, especially for indigenous sugar, are of no value in the matter of the regularity and certainty of the tax." . . . . . "It is evident that we are taking steps towards this, and that we shall arrive at it."

Out of eighteen members only five were opposed to this vote. This minority included the *Secrétaire général du Ministère de l'Agriculture et du Commerce* and the *Directeur général des Douanes*, who afterwards represented France at the International Conference.

On the first of August last, this Conference was opened in London. It was held, at the suggestion of Her Majesty's Government, for the purpose of considering the adoption of refining in bond, recommended in the above resolution by the Council to which the French Government had referred the question, and asked for by the trade of the four countries, when at a Trade Congress held in Brussels on the 17th and 18th of April last, it was resolved as follows :—

> "Has the Convention of 1864, by sanctioning the principle of equality

between the four contracting nations, attained its end? No. Is an immediate modification of the Convention necessary? Yes.

The Congress desires that the Governments taking part in the Convention of 1864, should be asked to open, with the shortest delay possible, an International Conference, with the view of coming to a common understanding as to a system of taxation, which should avoid all "drawback," and which, though allowing to the Sugar Industry every liberty as regards manufacture, should assure to the Treasury of each country the totality of tax, at the same time that the industry of each nation should have complete equality in its arrangements. Towards this end the Congress thinks right to recommend the study of the aforesaid system:—Refining in bond."

The third of these resolutions was voted by the delegates of the Belgian manufacturers of beetroot sugar, the French manufacturers of beetroot sugar, the Dutch refiners, and the British refiners.

The representatives of the English Government opened the Conference of the four powers by indicating the causes which have led to the necessity for a revision of the terms of the Convention, and stated that in the opinion of the English Government an international system of refining in bond can alone remedy the present inequalities.

The French representatives, declining to be guided by the decision of the Council to which their Government had referred the question, defended the present system of assessment by colour and classification of average qualities.

The delegates from Holland stated that their Government, before adopting refining in bond, wished to seek for other means of attaining the object of the Convention. In default of any such system it would not oppose the proposition of the English Government. They are reported, in the minutes of the Conference published in the second volume of the French "*Enquête*," to have made the following statement:—

"It appears indisputable that colour is no longer sufficient, and in every case it will not become more sufficient in the future, for ascertaining the saccharine content in sugars. . . . . Under these conditions the terms of the Convention no longer abolish, and the classification of sugars, according to their colour alone, will no longer suffice."

The Belgian delegates insisted that they had carried out the terms of the Convention, and had adopted all the measures necessary for stopping bounties on exportation.

As it is well known that the revenue realized by Belgium from its sugar duty is very much below what its consumption ought to yield, this statement appears to want confirmation.

They go on to say that their Government, for political and administrative reasons, can never accept refining in bond. Their explanations appear to point to the objections which would be raised by the manufacturers against such a system. But, in point of fact, its beetroot sugar manufacturers not only do not object to, but actually demand, the adoption of refining in bond, as is proved by documents emanating from their Central Committee, and by the Report of the Trade Congress, at Brussels, already referred to, which records their formal vote in favour of the measure.

The annual production of beetroot sugar in Belgium is now 75,000 tons, and the duty on that sugar is levied, not as in France on the sugar itself, but on the juice directly it is expressed from the root. As the main principle of the Convention is the classification of raw sugar according to its colour and the assessment of the duty according to this classification, we think we are right in saying that, though we are aware of the special clause in the Convention regulating the mode of duty payment on the juice as practised in Belgium, this circumstance places Belgium in an exceptional position with regard to the present question, and justifies us in hoping that if she insists on her present opposition to the proposed change, that determination may not be allowed to frustrate any arrangement which the other three powers may eventually agree upon. As, however, the manufacturers of beetroot sugar in Belgium, who represent the principal part of the sugar trade of the country, are nearly unanimous in asking for refining in bond, there is every hope that the Belgian Government will eventually be disposed to agree with the wishes of the other powers. There is also some expectation that as the revenue from sugar in Belgium is very small, the question of the total abolition of the duty in that country may soon arise.

Thus, the position of opinion on the subject in August last was that England saw no way of carrying out the object of the Convention, but by the adoption of refining in bond in the four countries; that France by the decision of the Council, to which the Government had referred the question, recommended the same system, though her delegates at the Conference supported a different view; that Holland would accept refining in bond, if all other alternatives failed; that Belgium alone definitely rejected the proposal, in spite of the wishes of her trade.

The French delegates, who, as we have explained, declined to be guided by the result of their recent official enquiry, prepared a series of propositions as a counter proposal to that of England. To these proposals the representatives of Holland and Belgium gave in their adhesion. The proposals were that sugar should still be classified according to its colour, but that such classification should be corrected by occasional resort to analysis; that the yields established by the experiments at Cologne should be altered; that France should establish a correlation between its duties and its drawbacks, and that Belgium should alter the basis on which it calculates the duty on its beetroot juice; that the Convention should be prolonged on this basis for two years. Though the question of refining in bond had not been discussed on its merits, these proposals conclude as follows:—

> "These proposals being of a nature to abolish more completely the complaints brought forward against the system of standards, it is needless to prolong the discussion on the question, whether the practice of refining in bond, required by certain interests, would not offer more disadvantages than advantages for the interests themselves, and for the financial prosperity of the contracting states."

With regard to this sweeping statement, which appears again in the protocol, we must remark that no argument had been brought forward in support of it; that the English delegates pointed out, at the fifth Conference, that the propositions would *not* "remove almost completely the complaints made against the system of types;" that the "certain interests" which demanded refining in bond were, as indicated by the resolutions passed at Brussels, the French and Belgian Sugar Manufacturers and the Dutch and

British Refiners, while the only interests opposed to it were the French and Belgian Refiners. As to the "finances of the contracting States," it had been argued both here and in France that the French revenue would lose at least twenty million francs in 1872 under the present system. This was characterized in August last, by the French delegates at the Conference as "*une pure fantasmagorie*;" but at the close of the year it was found that the loss from this cause amounted to between thirty and forty millions.

The English delegates proceeded to examine the counter propositions drawn up by France and agreed to by Holland and Belgium. They concluded by rejecting them, on the grounds that the application of analytical tests, as a means of assessing the duty on sugar, would be impracticable; that the adoption of such a system, to be resorted to only in doubtful cases, would throw an undesirable responsibility on the assessment officers, which might result in grave abuses; that a raising of the yields of the average qualities, classified according to their colour, could not remedy a defect in that classification arising from colour being a false guide to quality, while it would further injure the British refiners, who are supplied as a rule with the qualities of sugar below the average yield of their class, owing to the premium which can be given for the better qualities of each class in those countries where the duty and drawback are very high.

The English delegates might have urged, against the proposal to establish a correlation between the duties and drawbacks in France, that as it had been shown that the present mode of classification is false, and that in any system of classes, which are in fact *averages* of various qualities, the better qualities in each class are under-taxed, and the lower ones over-taxed, it would only aggravate the present state of things in France, whose recent increase of duty greatly magnifies the inequalities naturally arising from a classification by averages and the false estimation of quality according to colour, were to extend such a system, now applied only to sugar for exportation, to the still larger quantity which it takes for home consumption.

We have added this argument because it has an important bearing on the present project of the French Government now before the National Assembly, and to which we shall have occasion to allude.

These proposals having been thus definitely, and on good grounds, condemned by England, and the discussion of the English proposal for refining in bond having been avoided by France and declined by Belgium, the wish expressed by Holland to find some accurate and practicable alternative plan, before finally falling back on refining in bond, was resorted to. This wish appeared to point to the rejection both of classification by averages and the use of colour as a test, and towards the adoption of some system by which each parcel of sugar should be assessed according to its actual quality, to be ascertained by some method of analysis yet to be found.

It was therefore decided that each Government should be requested to study the question under this aspect through competent men, and to communicate the results of these studies before the 1st January of this year, all new arrangements being meanwhile adjourned. The Conferences were then closed.

We wish now to direct your attention to the course which has been pursued by the French Government since the Conference, the present position of the question before the National Assembly, and the feeling of that body on the subject, in order that we may show good grounds for asking that a fresh Conference be invited before any legislation can take place in France.

In order to carry out its fulfilment of the Treaty the French Government had prepared in 1871 a law bringing its duties into correlation with the classes of the Convention. This law was referred to a Commission of the National Assembly in 1871, but the report of this Commission was delayed when the proposal for refining in bond was made in the beginning of 1872.

As we have already explained, the representations which were made by England at the Conference of August, 1872, endorsed by Holland, and supported by the evidence given before the French Superior Council of Commerce, and by the decision of that Council, prove such a proposed extension of a now confessedly defective system to be only an aggravation of the previous evil. The Commission of the National Assembly became quite alive to this fact, and in its report, which was published in December last, it states, after describing the agitation which had taken place in favour of refining in bond, that it is bound to confine itself to its mission of making a law of correlation, "but it may be allowed to express regret that it found itself unable to alter the legislation in a manner more in conformity with justice, and with the interests of the Treasury than by giving up the system of standards." This report lays before the Assembly two projects of law—that of the Government and the same as amended by the Commission. It is not necessary to give these projects *in extenso*, because they have since been superseded by a third amended project emanating from the Government. There is one point in them, however, to which attention may be called in passing. This is in connection with the subject on which we addressed to the Treasury two memorials on December 13th and January 23rd last, namely, the new class which the project proposes to introduce *above* the classes established by the Convention. In the Government project this class is defined as "Brut, au dessus du No. 18," and the class above it is defined as "Poudre Blanche de qualité égale au type No. 3 de la Grande-Bretagne." Therefore the new class would include all sugar between No. 18 Dutch standard and No. 3 Export standard of Great Britain. The project of the Commission defines the new class as "raw sugars, indigenous sugar, colonial sugar, and that of the countries signing the Convention of 8th November, 1864, above No. 18," and it defines the class above it as "refining in loaf or powder." The new class in that case may include *all* sugar of the indigenous, that is beetroot factories, or of the colonial factories, which is above No. 18, whatever be its colour or quality.

The presentation of this report gave rise to a short debate in the Assembly, on December 19th, in which the errors of the present system were exposed; and when, on the following day, it was proposed to place the project of law upon the order of the day, an amended project was brought forward by four members of the Assembly, one of whom was the reporter of the Commission. It simply proposed that "from April 1st, 1873, sugar refineries will be subjected to inspection." The Assembly declared urgency and referred the proposition to the Sugar Commission.

About this time (that is, on December 20) a calculation was published in a French newspaper, entitled *La Sucrerie Indigène*, showing that the duty received during the first ten months of 1872 was less by 26 million francs than that which the quantity of sugar actually consumed ought to have produced. This calculation has never been contradicted, and it soon received full confirmation when the accounts for the year were published and it was found that the receipts from sugar were 65 million francs below the estimates. Part of this deficiency is, no doubt, to be accounted for by other causes, but there remains a sufficiently large one, after all fair allowances have been made, to justify fully the previsions which were made a year ago as to the probable loss which the French Treasury would sustain from the irregularities in the assessment, then for the first time greatly magnified by the recent increase in the duty.

The result has been that the export of French refined sugar, the annual average amount of which has till now been under 100,000 tons, attained in 1872 the unprecedented quantity of 141,000 tons. While the present system and the high duty in France continue, there is no reason why the increase should not go on in the same ratio, and the French refiners are making every preparation to enable them to maintain it.

The startling deficiency in the revenue from sugar, and the evident disposition of the National Assembly on that account to reject the Government project and demand a supervision of the refineries, led the Government to bring forward a modified project. This was referred to the Commission in the beginning of February, and runs as follows :—

## "THE NEW LAW CONCERNING SUGARS."

"The following is the scheme of the amended law sent to the Commission by the Minister of Commerce and Agriculture :

"Article 1. According to the promulgation of the present law, the rights concerning sugars will be established as follows, per 100 kilogrammes :

| | Produce in refined sugar for exportation. | Amount of duty. |
|---|---|---|
| "*Refined.* | | |
| "Candied ................................ | | 79 0 |
| "In loaf or powder ...................... | | 73 85 |
| "*Raw sugar, indigenous sugar, colonial "sugar, and that of the countries signing the "Convention of 8th November, 1864.*" | | |
| "Above No. 18.......................... | 97°/o | 71 60 |
| "From No. 15 inclusive to No. 18 inclusive.. | 94°/o | 69 40 |
| „ 10 „ „ 15 exclusive.. | 88°/o | 64 95 |
| „ 7 „ „ 10 „ .. | 80°/o | 59 05 |
| "Above No. 7 .......................... | 67°/o | 49 50 |

"Article 2. Sugars imported from countries out of Europe by foreign ships, and from European bonds, whatever the manner of transport, shall pay a surcharge of 2 francs per 100 kilos."

"Article 3. This surcharge will not be applicable to beet-root sugars of the countries signing the Convention of 8th November, 1864, whatever the mode of transport."

"Article 4. To facilitate and render more equitable the settlement of rights established by the present law upon sugars of whatever origin, and likewise too the settlement of the drawbacks arising from the Convention of 8th November, 1864, and from the declaration of 20th November, 1866, the administration of custom duties, indirect taxes and commerce each time doubts should arise as to the point whether the quality and the saccharine contents of sugars offered for importation or temporary admission are in bearing with the colour represented by the types of the Dutch series, recourse shall be had, for the definite classification, to chemical analysis as well as to the saccharometer."

"If the classification thus made by the agents of the Custom-houses and indirect taxes, is contested by the owners, recourse shall be had to legal appraisement instituted by Article 19, of the law of July 27th, 1822, and the appraisers shall employ the methods of control above mentioned."

"When the produce complained of shall exceed by analysis:—

"1st. 70°/o for sugars below No. 7, these sugars shall be classed in the category of sugars 7 to 9."

"2nd. 84°/o for sugars Nos. 7 to 9, these sugars shall be classed in the category of sugars 10 to 14."

"3rd. 91°/o for sugars Nos. 10 to 14, these sugars shall be classed in the category of 15 to 18."

"4th. 96°/o for sugars Nos. 15 to 18, these sugars shall be classed in the category of sugars above No. 18."

"Article 5. All the arrangements of the law of 7th May, 1864, of the Convention of 8th November of the same year, and the declarations of 20th November, 1866, and 8th November, 1868, not modified by the present law, are maintained in their form and tenure."

This law consists of three parts. In the first place it brings the duties into correlation with the yields established by the Convention. (With the addition of a new class not authorised by the Convention.) The French Government is now very anxious to carry out this part of the treaty, professedly for the reason that it has been urged to do so by the other powers, but Great Britain has, in conference with the other powers condemned the system of classification according to colour as no longer effectual, and therefore does not now demand that France shall complete her classification on that basis. In the second place the law proposes that the classification by colour shall be made more accurate by occasional resort to analysis as a test. This is not provided for by the Convention, and when proposed at the recent Conference, was rejected by Great Britain. In the third place it proposes a new classification of yields which is distinctly contrary to the terms of the Convention.

This law, together with, we presume, the ones which precede it and the one proposed in the Assembly, was debated on its first reading on the 13th, 14th, and 15th February. The debate, which was very animated, consisted principally of a thorough discussion of the systems of assessment by colour, assessment by analysis, and refining in bond. If the speeches, or the way in which they were received, are to be taken as indicating the feeling of the Assembly, there can be no doubt that it is strongly in favour of refining in bond. The vote was not taken, but was deferred, together with the further discussion of the subject, till the second reading of the Bills.

The prayer of this memorial is, that the French Government may be requested to hold another Conference with the other powers before it legislates. An examination of these debates of February 13, 14, and 15, and of the preliminary one of January 24th will show that this prayer is well founded, for it will be found that in spite of the evident disposition of the Assembly to settle the difficulty by establishing refining in bond, the French Government makes every effort, first, to pass its law before the Commission has had time to report on the counter project for refining in bond referred to it by the Assembly on December 20th, and when that fails, to induce the Assembly to discuss its law first and consider refining in bond afterwards. As this course is defended by the opponents of refining in bond, and opposed by its advocates, it is clearly the opinion of both sides that the success of the Government Bill would be virtually equivalent to the shelving of refining in bond. This is equally plain from the nature of the two projects, the one being an extension of the system of assessment by colour, which the other supersedes.

On January 24th, when the first reading of the Government Bill was on the order of the day, the President of the Commission of the National Assembly to which this and the counter projects had been referred requested an adjournment until the Commission should have time to report on the counter project for refining in bond. This is opposed by the Minister of Commerce which gives rise to considerable discussion. The Minister of Commerce assures the Assembly, again and again, that the Government proposal (rejected by England at the Conference as an aggravation of the present evils), while fulfilling its treaty obligations, will remedy in great part the evils which are complained of. The proposers of the counter project for refining in bond (of whom M. Pouyer-Quertier is one) argue that, while the proposed extension of the system of assessment by colour will in the same degree extend the evils of such a system, their amendment, which radically modifies the Government propositions, must be thoroughly studied and reported on by the Commission before further progress can be made. The President, Members, and Reporter of the Commission maintain the same view. The Reporter of the Commission says:—

"M. Henri Villain, *Reporter:* The Sugar Commission has before it three systems: the system of the Convention of 1864, which imposes on it the system of standards, from which they cannot escape; the system of M. the Minister of Finance, which at present insists on a radical modification of the system of 1864, namely, the introduction of the saccharimeter, which is exactly the opposite of the standards.

"Lastly, it has a third system, which is proposed by our honourable colleagues MM. Dupont, Paris, Pouyer-Quertier, and myself: that is refining in bond.

"These then are the three systems before us. The Commission is engaged every day. It came to a resolution yesterday; it asks you at present to adjourn the discussion, as it is impossible that a report can be laid down, and as, at present you might carry an act incomplete, bad for the Treasury. . . .

"If the Government instead of sending to London, two men absolutely antagonistic to that which has been proposed by the higher council.

"Several Members: Very good! quite true!

"M. the Reporter: It had sent there men having had no opinion previously settled on the question.

"M. the Minister of Agriculture and Commerce: And probably knowing nothing about it either!

"M. the Reporter: *Si!* knowing it perfectly, M. the Minister; but it is not only M. Ozenne who knows the question in France, you can find by his side men, who, with no other preoccupation than that of the Public Treasury, desiring only one thing that they should not quite ruin our industry, and who had not begun by saying to Belgium, 'We are not favourable to refining in bond, side you with us!' And whenever one would thoroughly understand the protocol drawn up at the time of these negociations, it is there where you may read it.

"From divers seats: Yes! Yes! That's a fact!

"M. the Reporter: Being in this situation, we ask an adjournment. This is a serious question, gentlemen, the interests of the public treasury demand our attention above all, and we ask you to be kind enough not at present to press your resolutions."

The Minister urges the Assembly to pass the Government law first and discuss refining in bond afterwards. M. Leurent, Member of the Budget Commission, in supporting the adjournment of the condideration of the Government proposal, makes the following remarks:—

"If this law is favourable to French industry, the other powers will not fail to object to it; if it is hurtful to our industry they will say nothing. I think then that we cannot discuss the question here at present. But Government, which should desire to see the losses of the Treasury put a stop to with the least possible delay, should promote a reunion of the delegates of the four powers and tell them. In 1864, after experiments which have lasted more than six months, in the great refinery of Cologne, we laid down as a base for tax, such or such produce for such or such standard. Now it is said that these bases are as false for the one as for the other, and are as productive of fraud with you as with us. Let us join and correct the system.

I do not know which side will prevail, I do not wish to prejudge, I understand M. Clapier's love for the saccharimeter. Those who have followed the discussions which have taken place before the Legislative Assembly, in 1849 and in 1850, remember that the saccharimeter is perfectly applicable to indigenous sugar, but not to exotic sugar, and I think that M. Clapier, who taunts every one with speaking for his own personal interest in this matter, does not forget his own, or at least the interest of Marseilles."

"M. CLAPIER: What! why there are only two refineries at Marseilles, the rest are at Paris."

"M. LEURENT: As for me, I am above all personal considerations, and my opinion is that Government should begin to promote a reunion of the delegates of the four powers to discuss together what it will be best to do."

"M. THE MINISTER OF AGRICULTURE AND COMMERCE: There is one which should take place in six weeks."

"M. LEURENT: M. the Minister tells us that there will be a meeting in six weeks. I am very glad to hear it. However, allow me to inform M. the Minister that it is probable that Belgium will again play the same *rolê* as it did at London, that of dissolving the Conference, because in Belgium frauds are committed which increase it from ten to eleven millions. But, if it does not wish to accept the conditions adopted by the Conference, Belgium can retire; for it is not necessary that a small state should prevent large countries such as England and France from acting according to their interests and according to justice.

"Since M. the Minister tells us that there will be a reunion of the members of the International Convention in six weeks, I think that, from now till then, we can do no better than study the question."

An adjournment was at last agreed to till February 3rd, but the debate was not renewed till February 13, and then lasted three days with the result already described. In the meantime, the Commission had completed its report on the project of law for refining in bond. This was published in the *Journal Officiel* of February 21st, 1873. It appears from this report that two of the authors of the project were of opinion that negociations should be opened with the other powers in order to establish refining in bond under identical conditions in the four countries, while the others considered that the Convention did not oppose the establishment of refining in bond, and that, therefore, it should be adopted immediately. They declined to accept the argument of the refiners, that if subjected *alone* to this system they could not contend against their competitors in the other countries, because, the refiners having declared in the *Enquête*, that they obtained nothing above the legal yields, a supervision of their refineries would in no way alter their position. If, on the other hand, in spite of the affirmations of the refiners, such excess above the legal yield did exist, the large bounty which must now arise from any such excess would be returned to its proper channel. In any case the exportation of the country would not be affected. None were more interested in that exportation than the beet sugar manufacturers, and they were unanimous in demanding refining in bond.

The Commission, like the authors of the project, were equally divided, six being in favour of immediate adoption of the system without previous negociation with foreign powers, six wishing that previous understanding should be come to with the co-contracting Governments. Under these circumstances the Commission only proposed that the Assembly should decide on the *principle* of refining in bond. It declined to examine the amended project of the Government. "Qui aggrave les droits déjà si lourds, change l'impôt des types en un impôt sacchrimétrique avec une échelle absolument arbitraire et que rien ne justifie."

This was the position of the refining in bond question when the Assembly resumed the debate on the 13th February.

It will be noticed that the Commission, in its report, alludes to the raw sugar makers of France, who produce annually 100,000 tons more than the consumption of the country, as being the party really interested in the extension of the export of sugar, and yet the one which most unanimously demands refining in bond. Great efforts have been made lately by the opponents of refining in bond to destroy the unanimity of this wide-spread interest. The report of a meeting of the Central Committee of the beet sugar manufacturers, held on the 31st January, shows the failure of these efforts.

From this report it will be seen that meetings of the manufacturers have been held in all the centres of the beet sugar production, and have unanimously supported the Central

Committee, condemning assessment by colour or analysis, demanding refining in bond, and the representation of France at a fresh Conference by Commissioners who will be guided by the decision of the Superior Council of Commerce.

In the appendix to the report will be found the resolutions of the Central Committee, which give the reasons why they unanimously reject the proposal for assessment by analysis, and demand the transfer of the duty from the raw material to the finished product, which can be carried out by extending to 33 refineries the permanent supervision which is now applied with complete success to 520 sugar factories.

The adjourned debate was resumed in the National Assembly on February 13th by the Minister of Commerce, who again urged the acceptance of the Government Bill, in order to fulfil the Treaty of 1864. He admits, in the following words, the main contention of those who advocate the substitution of refining in bond for the present system, which neither the provisions of the Government Bill nor the proposals of France at the Conference suffice to meet.

> "The Commission has wished to make allusion to the improvements introduced in the manufacture of indigenous sugar, and which result in raising the saccharimetrical appearance of raw sugars without changing in any notable manner their external appearance, the colour base of the tax.
>
> "You understand, gentlemen, from the time when several categories of sugars were combined under the classes recognized by the Convention, the produce assigned to each class was an average between an inferior type which was less rich than the average, and a better type which showed a higher produce. It results from this, that there is an evident advantage in producing the highest standard, so that, the progress of the manufacture continuing, we may arrive, in certain number of works, at producing no other than the highest produce. By this method, we may manage to hide, I do not say in an irregular manner, in an illegal manner—for one uses the law for himself, one takes the best side possible, I accuse nobody—we may manage to hide from the eyes of the Treasury a certain amount of sugar, which multiplied by the amount of production, might constitute a very large amount."

This is an admission, first, that colour no longer serves as a guide to the quality of sugar, and, secondly, that classification by averages permits an excess yield equal to the difference of yield between one class and another. How does the Government Bill propose to remedy these two defects? The Minister describes the system of analysis now used in commercial transactions in sugar, and says:—

> "Well, gentlemen, we who are engaged in the interests of the Treasury, we, whose duty is the preservation of these interests, we are told that we hold in our hands a method, simple and perfect, showing everyone what the Treasury should do, and that the rule which had been accepted by commerce, and which to day served as the ground work of all transactions, could serve, with the same certainty, for settling the amount of the tax.
>
> "That then is the second and the last end of the project of the law submitted to you. The first end we strive for is to establish a correlation; the second is, that in establishing this correlation the interests of the Treasury should not only not suffer, but that the Treasury should receive all that it ought to receive."

On referring to the Bill, it will be found that sugar is still to be classified according to its colour, and that this classification is to be extended to the sugar which is used or refined for home consumption. The application of analysis as a test is to take place "toutes les fois que des doutes s'élèveront sur le point de savoir si la qualité et la richesse saccharine des sucres présentés a l'importation ou à l'admission temporaire sont en rapport avec la nuance représentée par les types de la série hollandaise." As it has been admitted that colour is no longer a test, and also that a class must include various qualities, this necessity must arise on every occasion if the evil just pointed out by the Minister as arising from a class comprising various qualities is to be remedied. It is clear that this is not the intention, as it would involve an abandonment of the classification given in Article 1, and the assessment of each sugar according to its actual analysis. The latter part of Article 4 is intended to meet this difficulty, but it only provides that *in the cases where analysis is resorted to*, sugar may be charged with an amount of duty from 3 to 10 per cent. above what is in proportion to its yield. This is clearly contrary both to the letter and spirit of the Convention. Nevertheless, these provisions are recommended by the Government to the National Assembly as sufficient to remedy the evils complained of, and we fear that the Assembly, naturally feeling that the Government ought to be the best judge of the interests of the Treasury, and not understanding the subject sufficiently well to see the flaws which we have indicated in the law, may be disposed to pass them in spite of the eloquent and convincing speeches of those who advocate refining in bond. If the National Assembly passes the Government law, we cannot see how any motive can possibly induce it to consider *afterwards* the question of refining in bond. This, however, is what the Minister of Commerce proposes. He says:—

> "We ask you to establish the practice of refining in bond; we ask you to modify the basis of the International Convention. The Government has no objection to make to the discussion of these projects; not only does it not refuse to examine them, but if a reasonable solution is arrived at, it asks nothing better than to make them the base of the negotiations which will be opened with the contracting powers. We only say that to-morrow's work is there, and we ask the Assembly to make themselves acquainted with that work to-day. That is to say, that confining themselves exclusively to the examination of the project of the law which we have laid before them, they would give us at once the right to establish the correlation which we are engaged in working out, afterwards when accepting this correlation, they will authorize us to make use of the means of control which are now employed exclusively in commerce, and which are as good and efficacious for us, as they can be for it."

We think we are right in expressing a fear that if this course be adopted it will be equivalent to a final defeat of the proposal made by England for refining in bond.

As our object is only to point out this danger, we need not go into a further examination of this debate. It resulted, as we have said, in a great argumentative triumph for the advocates of refining in bond, but the vote of the Assembly was postponed till the second reading.

The *Journal des Fabricants de Sucre*, for February 20, thus describes the conclusion of the debate:—

> "The Assembly at a second meeting, without an hour's delay, rejected the second reading, and voted against the types. But the Commission could not see the question thus abruptly settled, and its reporter, M. Henri Villain, got up and said, in excellent terms, that they had no claim to slur over a debate of such importance as this, that light should be thrown upon it, and that they had no reason to object to a second reading not only upon a part, but upon the whole of the project. The Assembly voted accordingly, and

decided that they would pass a second reading upon the two projects, that of the Government, and that of the Commission, the latter concluding in favour of the tax upon the finished product."

Having endeavoured to show the existing danger that the French Government project may, in spite of all arguments to the contrary, be passed by the National Assembly, and the scheme proposed by Great Britain at the Conference thus rendered more difficult of accomplishment, and having explained why we believe that the French Government project will not remedy the evils complained of—an opinion which is supported by the fact that similar proposals were rejected by the representatives of Great Britain at the Conference—we conclude by recapitulating the reasons which appear to us to justify the interference of Her Majesty's Government, in order that another Conference may be held before the French project of law is further proceeded with.

The French Government urges the National Assembly to pass the proposed law, because :—

1. It carries out the treaty obligations of France.

2. It contains provisions for remedying the evils of assessment by colour and a classified scale.

The English Government may urge, in favour of a Conference before the law is proceeded with, that—

1. Great Britain has stated, at the recent conference, that it can no longer regard a classification by colour, or any classification of average qualities, as sufficient to check bounties on the exportation of refined sugar. Therefore, its demand that France should carry out its treaty obligations by extending the system of classification by colour to its duties on home consumption falls to the ground.

2. The means which the proposed law provides for remedying the defects of the present system are the resort to analysis in doubtful cases, to check the error of classification by colour. This proposal was made at the Conference and rejected by Great Britain as an aggravation of the existing evils. It ought not, therefore, to form the main provision of a new law in France without further reference to the wishes of Great Britain. Even if this had not been so, there is no provision in the terms of the

Convention for the classification of sugar according to its analysis.

3. It was decided at the Conference, that, as no system of analysis at present exists by which the yields of the various quali- of raw sugar can be satisfactorily determined, each Government should study the question and report the result of its enquiries. It is not desirable, therefore, that the French Government should pass a law based partly on assessment by analysis, when no international agreement has been come to as to what system of analysis, if any, should be employed.

4. Even if the errors of classification by colour were successfully remedied by occasional resort to analytical tests, the permanent errors arising from a classification by averages are in no way affected. Thus, if a sugar which by its colour belonged to the class having an average yield of 80 per cent. were found by analysis to yield 87 per cent., it would still remain in the lower class and give to the refiner a legalized excess of 7 per cent. The French project of law proposes that if such a sugar shows on analysis a yield over 84 per cent. it shall be classed with the sugars having an average yield of 88 per cent., but this appears to be beyond the powers given by the Convention, and if it were not it would still legalize an excess yield of 4 per cent., which is equivalent to 1s. 2d. per cwt. at the present rate of duty in France. A practicable system of analysis applicable to all sugar, when found, could only remedy the present evils by superseding a classification of averages, and establishing the assessment of a duty on each sample in proportion to its estimated yield as determined by such analysis.

5. If it be argued by France that refining in bond cannot be adopted because Belgium refuses to agree, it can be equally well argued that analysis, as a check upon classification by colour, cannot be adopted because England has refused to agree to such an arrangement. Refining in bond, maintained by Great Britain to be the only means of carrying out the object of the Treaty, might be shown to be within the terms of the Convention as it stands, because payment of duty on the refined sugar is an exact payment of duty according to the yield of the raw material, but a combined

system of assessment by colour and analysis cannot be defended as being within even the spirit of the Convention, both for the reasons already given and because it has been officially condemned as giving a discretionary power to the Customs officers which might lead to grave abuses.

These reasons appearing to justify such a course, we pray that Her Majesty's Government will at once make such representations to the Government of France as will lead to the immediate holding of another Conference and to a delay in the progress of the French project of law until the four powers have agreed on a united course of action.

We also renew our request that Her Majesty's Government will take all possible steps towards the International adoption of the only practical solution of the difficulties surrounding the taxation of any article of manufacture, namely, the levying of the tax on the finished product as it goes to the consumer.

*March 3, 1873.*

### STOCKS OF SUGAR IN THE CHIEF MARKETS OF THE WORLD ON THE 31ST JANUARY, FOR THREE YEARS, IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

| | 1873. | 1872. | 1871. |
|---|---|---|---|
| Great Britain | 143 | 108 | 109 |
| France | 160 | 71 | 132 |
| Holland | 46 | 35 | 20 |
| Germany (Zollverein) | 49 | 36 | 41 |
| Six other *entrepôts* | 8 | 4 | 4 |
| Total in Europe | 406 | 254 | 306 |
| United States | 41 | 46 | 40 |
| Total in Europe & United States | 447 | 300 | 346 |

## SUGAR STATISTICS—GREAT BRITAIN.

To 22nd March, 1873 and 1872. In Thousands of Tons, to the Nearest Thousand.

| | STOCKS. | | | | | | IMPORTS. | | | | | | DELIVERIES. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. |
| British West India | 12 | 2 | 1 | 9 | 24 | 13 | 8 | 2 | 2 | 4 | 16 | 17 | 14 | 2 | 2 | 11 | 29 | 26 |
| British East India | 15 | 3 | .. | .. | 18 | 4 | 11 | 2 | .. | .. | 13 | 3 | 5 | 2 | .. | .. | 7 | 6 |
| Mauritius ...... | 5 | 2 | .. | 4 | 11 | 8 | 6 | 1 | 3 | 5 | 15 | 18 | 5 | .. | 4 | 2 | 11 | 16 |
| Cuba .......... | 2 | 1 | .. | 8 | 11 | 6 | .. | .. | 2 | 2 | 4 | 2 | 2 | .. | 2 | 6 | 10 | 6 |
| Porto Rico, &c. .. | 1 | 5 | .. | 1 | 7 | 3 | .. | 5 | .. | 1 | 6 | 2 | 2 | 2 | .. | 1 | 5 | 3 |
| Manilla & Java .. | 19 | 7 | 2 | 3 | 31 | 26 | 3 | 4 | 4 | 2 | 13 | 19 | 6 | 3 | 2 | 2 | 13 | 15 |
| Brazil .......... | 1 | 18 | 1 | 5 | 25 | 18 | 1 | 15 | 2 | 2 | 20 | 18 | 1 | 10 | 2 | 2 | 15 | 14 |
| Beetroot, &c. .... | 5 | 1 | 1 | 4 | 11 | 18 | 8 | 5 | 4 | 15 | 32 | 39 | 10 | 5 | 5 | 21 | 41 | 38 |
| Total, 1873 .. | 60 | 39 | 5 | 34 | 138 | 96 | 37 | 34 | 17 | 31 | 119 | 118 | 45 | 24 | 17 | 45 | 131 | 124 |
| Total, 1872 .. | 37 | 26 | 5 | 28 | 42 increase | | 33 | 27 | 16 | 43 | 1 increase | | 37 | 27 | 15 | 45 | 7 increase | |

## STATE AND PROSPECTS OF THE SUGAR MARKET.

The sugar market during the last month has been dull, with a slightly downward tendency. Arrivals have come in freely, and these, together with the surplus quantity which we last month noticed, kept out of port by contrary winds, have had the effect of causing extreme caution to be observed in all the transactions in the raw market. The result of this is, that raw sugar is now cheaper than it has been since 1870—a circumstance which at this time of the year is remarkable. The floating cargoes destined for the United Kingdom still show a considerable excess over those bound for the same ports this time last year.

No. 12 Havana afloat is now quoted at 27s. per cwt., being 6d. lower than last month, and 2s. 6d. lower than in 1872; fair to good refining Muscovadoes are worth 24s. to 24s. 6d., about the same as last month; middling to good brown Bahia, 19s. 6d. to 20s. 6d., a decline of 9d. Jaggery and other low sugars in London are still relatively somewhat depressed, owing to the abnormal proportion of these descriptions; still a fair trade has been done in them.

As to the coming crop, the best authorities place it at a fair average, though in Cuba, owing to the lateness of the season consequent upon the unfavourable weather which has there prevailed, the estimates are less reliable than usual. There is also to report a slight increase in the estimate of the beetroot crop. These circumstances of course all contribute to keep down the price of raw sugar, but it is a fact which should by no means escape attention, that the present rates are low compared with the amount of stocks. If from any of those causes, which may any moment arise, the favourable anticipations of the coming season's supply are not realized, doubtless a reaction may be looked for.

The course of the refined market has on the whole kept pace with that of the raw. Low refined goods from 29s. to 33s., are however in better demand than last month. Common lumps are quoted at 38s. 6d. to 39s. per cwt.

# THE
# SUGAR CANE.

No. 46. MAY 1, 1873. Vol. V.

☞ The writers alone are responsible for their statements.

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## THE RECENT CHANGE IN THE SUGAR DUTIES.

Since the last number of this magazine was published an important change has occurred in the affairs of those engaged in manufacturing sugar and trading in it. The duties are to be reduced one half. Since the hope raised by Mr. Bright, that we might soon have a free breakfast table, there has been a struggle each successive year to this end. We must always have some admiration for a movement to lessen the burden of the nation, but that admiration cannot always be given to the mode of accomplishing the object. Mr. Lowe has raised objections among a class of men who think themselves unfairly used and we think with reason. We allude to the refiners. Were it necessary that they should suffer, we should simply say, that it was better that they should do so, rather than that the whole nation should continue to be burdened.

Mr, Lowe, reducing the duties, allows one month, namely, till the 8th of May, in order to give time to refiners and others holding duty paid sugars to realize their stocks, and after consultation with Sir Thomas Freemantle and Mr. R. A. Ogilvie, consents to extend the time between the reduction of the duties on raw sugar and of those on refined to the 28th May,—that is, twenty days.

We cannot doubt that refiners generally will be the gainers in the long run, but we still less doubt that they will be losers for a time, and we think the loss is *not* a public benefit, or one which will bring compensation in every case to those who are most interested.

Let us consider the refiner's position. He has bought raw sugar at a high duty. He sells it refined at a price which the public will expect to be less, in proportion to the lowering of the duty, and the public must be obeyed, in other words, the refiner presents to the public a large sum of money.

In this country, the refiners are required to advance the duty paid on the public account, so that when the duty is reduced they are left to lose the money they have advanced. In France, on the contrary, the Government gives the refiner credit for duty paid on behalf of the public. So that in England the loss of the refiners on sugar in stock and on that undergoing refining will be, in the present instance, in rough numbers, about £60,000; and as the case at present stands, either this loss must be incurred or the refinery stopped, the loss thus sustained being a still greater one.

But then Mr. Lowe allows the refiner a month to realize his stock. This we are afraid is a very inadequate period for such important sales. Of course, there may be some refiners in this enviable position, and it may be that from these he has taken an opinion, but that they are exceptions is our belief, and the trade is left to suffer by an act of arbitrary power, just as communities have in all ages suffered whenever arbitrary power has been given to one man, because no one man, however well meaning, can know the conditions of the people sufficiently well.

The consequence is clear and is already seen. Refiners must stop their works for a certain time, and some are doing so, certainly in some cases that is already a sufficient proof of loss.

Why do they not continue to work? The reason is clear, they cannot expect to sell their stock at a high rate when in a month they are obliged to sell it at a low rate. It is true that by this means the stocks in the hands of the public and the wholesale grocers for example will become smaller, but meanwhile the work is stopped, the trade is deranged, and the workmen suffer as a necessity, whilst there is no certainty to the master that he can begin again in such a way as to make compensation for the past. Matters will probably complicate themselves, and we think in such a way as to diminish the consumption until adjustment is made. The discussion of the future is difficult, but the present is certain, and that is simply stoppage and loss.

If the time were lengthened similar difficulties would occur and we see no good plan but that of simply stopping all duties *at once* and allowing a drawback to all who have stocks of sugar above a certain amount: we know from experience that it would be no difficult matter to obtain this knowledge, and no man could complain of the result.

Why then, when it is so easy, are the refiners to be condemned to such heavy fines? It must diminish the sweetness of the breakfast sugar to know that so many men must go without sugar or breakfast at all in order to obtain the change.

Mr. Grieve, the member for Greenock, made so many good remarks upon this subject, after the reading of the Budget, that we feel inclined to reproduce them here:—

"I accept the reduction of duty on sugar with satisfaction, and hope it is only the precursor of the whole being swept away. I fear, however, the right hon. gentleman will give a good deal of dissatisfaction by his announcement. When the right hon. gentleman in 1870 introduced his Budget, regarding sugar he spoke as follows:—'I wish it to be clearly understood in making this proposal I am against preparing the way for either further reduction or abolition; but that I have gone as far as I intend, and make the declaration in order to give stability to the trade, and free it from periodical annoyance owing to apprehension of changes.' The trade will be thrown into confusion for the next month to come, and there will be a loss of revenue, and I would strongly urge upon the right hon. gentleman to adopt the principle finally resorted to in 1870, namely, to bring into operation the reduction of the duty at once, giving drawback for refined goods actually on hand. I am aware the right hon. gentleman is not in favour of drawbacks as a rule; but in this case it is just, and he has even insinuated that in 1870 some malpractices were resorted to. I challenge the right hon. gentleman or the Customs authorities to produce the shadow of a case of the kind in the town I have the honour to represent. Perhaps the right hon. gentleman will not take my advice, but he will perhaps see some force in it if he learns that in a few days half the sugar houses in the

United Kingdom are shut for the next four weeks. It stands to reason that a refiner will not pay duty on raw sugar, at say an average of 4s. per hundredweight, when he knows that he can in four weeks pay duty at the rate of 2s. per hundredweight. Grocers will only buy from hand to mouth, and the trade will be paralysed. I fear this reduction of duty will not reach the large consumers—the working classes—for we all know it is almost impossible for a retailer to split a farthing per pound, which is in round numbers the proposed reduction. I could have wished the right hon. gentleman had seen his way to have swept away all the duty on sugar, and allowed the Income Tax to stand over for another year."

However this may be, we have no doubt that in the long run we shall see the whole of the sugar duties swept off and Mr. Lowe can then turn his attention to some of the other articles which go to constitute—" a free breakfast table!"

## SACCHARIGENOUS MANURE.

### By Prof. Mussa.

The consumption of sugar is continually increasing, it is in fact becoming as a household article as necessary as salt. The enquiry is then not out of place, whether it is possible to increase its production, whilst at the same time diminishing its cost? Science has not yet succeeded in producing sugar from mineral elements; the increase of its production by artificial means in the organic kingdom is, however an accomplished fact. It is met with in organic beings, both animal and vegetable, in a larger proportion however in the latter than in the former.

Chemists recognize three different classes of sugar; the first which they call *superhydrogenised* sugar, has its type in *Mannite* ($C^{12}H^{14}O^{12}$). The second, *Glucose*, or grape sugar ($C^{12}H^{12}O^{12}$), is found in grapes, and in most other fruits.

Glucose can be produced artificially by means of starch, water, and sulphuric acid, at a temperature not above 75° C. Should however the temperature rise to the boiling point, the starch is not transformed into sugar. Glucose is not a product peculiar to one, or even to a few plants, but is a general element of food for all, and a necessary condition of vital exchange. From its first shooting, to the ripening of its fruit, the plant requires glucose for its formation. But the seeds themselves do not contain sugar; they contain starch, which being insoluble can not circulate through, and is thus incapable of acting as an article of food for the plant. To become fit for use the starch must be changed into glucose. Seeds and plants in general must then contain some agent as capable of producing this change as sulphuric acid. This agent is diastase.

If we bring into a pulp 10 parts by weight of barley malt, with 80 parts of tepid water, digest it for some hours at a moderate temperature, and then filter it, the filtered liquor contains diastase, a substance not yet exactly defined, but which is known by its effect of changing starch into sugar. If we pour this liquor on 40 parts of starch, mixed with 320 parts of water, and warm the whole up to 75°C, till the liquid becomes quite clear and transparent, then boil, filter, and lastly concentrate by evaporation at a moderate temperature, we shall find that all the starch has been converted into sugar. It is by this process that brewers and distillers ferment starch. By the aid of the diastase in the malt it is changed into glucose. The small white grains which are generally seen on the surface of figs, plums, and old raisins, and which increase the sweetness of dried fruits are composed of this glucose. Its sweetening power is however much inferior to that of sugar proper. It is very to recognise this by tasting them in turn. The sweetening power of sugar proper is two and a half times more than that of glucose.

The third group is that of sugar proper, or ordinary sugar, or sucrose, ($C_{12}H_{11}O_{11}$). It contains one equivalent of water less than glucose. It is found more or less in every plant, but more abundantly in sugar cane, beetroot, maize, sorgho, in the sap of the maple tree, in gourds, enelons, etc., indeed in almost every fruit. By various physiological changes it is converted into glucose, since, although plants produce it, they can not use it before this transformation takes place. This change is effected by its taking up an equivalent of water, and thus forming glucose ($C_{12}H_{11}O_{11}+HO=C_{12}H_{12}O_{12}$). Sucrose is not then by itself a restoring food for the plants that produce it, as is glucose, but is a sort of accretion, or reserve, or store for future preparation of food. It is intermediate between starch and glucose. When the plant needs glucose for its growth, it would be far too long an operation to obtain it from starch, and as it cannot keep a supply sufficient for all its wants ready in the form of glucose, it stores it up half prepared in the form of sucrose, and when required, it adds to it one more equivalent of water, and so obtains it in the necessary form of glucose.

To obtain sucrose out of plants, it is necessary to know the time when the plants have the greatest amount in store, and have not begun to consume it. This is immediately before blooming, *i.e.*, towards the end of the first period of vegetation; (The lives of plants may be divided into two periods, one from germination to blooming, the other from blooming to the maturity of the new seeds. During the first, plants absorb from without what is required for almost the whole of their accretion, utilising part of it currently for their growth, and storing the rest for future and eventual wants. During the second period of vegetation this store is utilised.)

The transformation of sugar into glucose can also be effected artificially by means of mineral agents. Thus diluted, acids transform sugar into glucose. Crushing to powder by mechanical action has the same effect. For this reason pulverised sugar sweetens less than lump sugar, because part of it has been converted, by pounding, into glucose.

The third group, sucrose, is the one which manufacture chiefly extracts from plants and brings to consumption, as it is the only one crystallizable, and is most sweetening. Manufacture, however, only extracts it from such sugar producing plants as contain the largest quantities, such as the sugar cane and the beetroot.

We abstain from dilating on the methods of detecting and analyzing sugar contained in these or other plants, neither will we touch on the processes of extraction and refining of sugar; our chief aim is to show that by appropriate manure the proportion of sugar produced by, and thus the quantity extracted from these plants, can be increased.

Professor Ville, well known for his work on chemical manures, lately indicated a manure capable of producing three beneficial effects on the culture of cane and beetroot, viz. : increase of crop, increase in proportion of sugar in the plant, and diminution of mineral substances in the same plant. Such a manure would be of the greatest benefit both to the cultivator and the manufacturer. For it is a well known fact that with equal conditions of climate, nature of soil, and variety of cultivated plants, the difference in the manure alone, determines the difference in the quantity of the crops. The greatest yield obtained by farm yard manure has been as yet tons per acre, but the average crop by such manure is 40,000 kils. per hectare. The greatest crop of beetroots known was obtained by the use of Mr. Ville's chemical manure, being 142,000 kils. per hectare, the average crop however by this manure being 9200 kils. hectare. No higheryield has been known to have been obtained by the use of any other manure.

The same effect is produced in the sugar cane. The yield obtained by chemical manure has amounted to 80,000 kils. per hectare. For *quantity* of crop, chemical manure is thus the best means of producing the production of sugar.

The quantity of crop however would be of very little consequence if the saccharine quality of the plant was inferior, as its market value, and, consequently, the profit, would be less. Some manufacturers in buying the crops of some Belgian cultivators stipulated that such and such a manure should not be employed in its culture, as, although the yield was greater the saccharine quality was inferior.

According to the so-called *mineral system,* the manure supplied to plants should be composed of the minerals that are found in the ashes of the plants to be cultivated, and more particularly that one which is present in the greatest quantity, and as the ashes of beetroot and sugar cane contain a large proportion of potash, so the believers in that system made, both in France and elsewhere, great efforts to improve the saccharine quality of beetroot, by the aid of potassic manure. According to the statements in a book lately published in Paris,*

potassic manure so improved the saccharine quality of beetroot in Germany as to give 19 per cent. of sugar, whilst in France the same manure produced no sensible effect. The French failure in this manure, is based according to that book on the experiments of Corenwinder, (who considers however that the soil on which the experiments were made was not fit for saline manure,) and on the experiments made at Grignon. But the propensity of the author to generalize these experiments made at Grignon, or his own made at the same place, is rather too manifest. His assertions then cannot be considered as conclusive.

The numerous experiments made throughout France with M. Ville's chemical manure especially composed for beetroot,—in which manure a special part is assigned to potash,—have been equally successful in improving the saccharine quality of the roots, in Germany, Belgium, and elsewhere. Leaving then aside the too partial assertions of the professor of Grignon, it is a fact that potash employed in a proper manner so improves the saccharine quality of beetroot, as to cause it to attain 19 per cent. of sugar.

But the per centage of sugar in the roots, and the quantity of sugar which can be extracted from the same roots, are two very different things. Sugar manufacturers determine the prices of the beets according to the quantity of sugar they can extract, and not according to the amount contained in the root. It is a fact that that the more saline matter the beets contain the less sugar can be extracted, whatever its saccharine richness may be. Now it is another ascertained fact that such potassic manure as came into vogue through the mineral system and the Hassfust mine—exclusively, or almost exclusively, potassic manure,—increases the saline matter in the beetroot, and consequently renders the extraction of sugar more difficult.

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(*.) Déherain.—Cours de Chemie Agricole.

M. Ville's chemical manures do not produce such effects, because in them there is no such excess of isolated potash. The other ingredients of that manure, viz.: nitrogen, phosphoric acid, and chalk, which have both a separate action, and moderate each other's action, being mixed in suitable proportions with potash, increase the good, at the same time lowering the evil effects.

The latest formula brought forward by M. Ville for manure required for beetroot culture, has another advantage in the form of nitrogen, which is that of nitrate of lime, so whilst that chemical manure generally increased the crop and the saccharine quality of plant, the latest formula greatly diminishes the proportion of saline matter.

M. Ville's experiments were made on beetroot and on giant maize, which is closely related to the sugar cane. So his conclu-clusions bear upon both these sugar plants.

There is not a word in the book alluded to, either in the chapter treating upon the influence of manure, etc., or in the chapter on the influence of potash on secretion of sugar in the beetroot on the direct developement of the principles of plants. It would be astonishing to find such an omission in a new work of such pretension, if it were not evident from the work itself that either the author was not fully acquainted with some of the facts of organic chemistry, or that he did not are to be familiar with those of chemical manure.

By the latest improvements made in the composition of chemical manures for sugar plants, Ville's system of chemical manures is now brought before beetroot cultivators under the new title of *Saccharigenous Manures*, as they not only tend to increase the crop, and the saccharine richness, but facilitate the extraction of sugar by diminishing the amount of saline matter in the ashes. We give below a demonstration of this fact shown by the results of M. Pagnoils' analysis of beetroots which had remained in the pits till January and which were beginning to bud.

The following tables are extracted from the *Revue Scientifique, des Cours*, January, 1873.

*Beetroots grown in an experimental field at Vincennes.*

LOT 1.

| | Weight of beetroots. gr. | Density of the juice. | Sugar per cent of beetroot. | Salts per cent of sugar. |
|---|---|---|---|---|
| No. 1 ........ | 1·629 | 1·054 | 10·1 | 6·6 |
| No. 2 ........ | 1·354 | 1·060 | 11·9 | 5·9 |
| No. 3 ........ | 1·107 | 1.078 | 14·3 | 3·2 |
| No. 4 ........ | ·702 | 1·073 | 15·2 | 1·9 |
| No. 5 ........ | ·457 | 1·074 | 15·0 | 2·1 |

*Average for the month of January.*

Sugar......, 13·3 per cent. of the roots.
Salts ...... 3·9 per cent. of the sugar.

LOT 2.

| | gr. | | | |
|---|---|---|---|---|
| No. 1 ........ | 1·705 | 1·059 | 11·4 | 6·4 |
| No. 2 ........ | 1·288 | 1·083 | 16·1 | 2·8 |
| No. 3 ........ | 1·129 | 1·080 | 16·3 | 2·4 |
| No. 4 ........ | ·798 | 1·079 | 15·3 | 4·5 |
| No. 5 ........ | ·309 | 1·092 | 17·9 | 2·3 |

*Average for the month of January.*

Sugar ...... 15·4 per cent. of roots.
Salts ...... 3·6 per cent. of sugar.

LOT 3.

| | gr. | | | |
|---|---|---|---|---|
| No. 1 ........ | 1·803 | 1·069 | 12·5 | 4·3 |
| No. 2 ........ | 1·121 | 1·060 | 13·0 | 3·3 |
| No. 3 ........ | ·685 | 1·065 | 15·4 | 1·3 |
| No. 4 ........ | ·612 | 1·079 | 17·2 | 1·4 |

*Average for the month of January.*

Sugar ...... 14·5 per cent. of roots.
Salts ...... 2·6 per cent. of sugar.

*Beetroots produced by regular culture.*

| | Weight of roots. gr. | Density of the juice. | Sugar per cent. of root. | Salts per cent. of sugar. |
|---|---|---|---|---|
| No. 1 ........ | 3·677 | 1·042 | 7·3 | 11·6 |
| No. 2 ........ | 1·500 | 1·050 | 9·2 | 9·6 |
| No. 3 ........ | 1·240 | 1·047 | 8·0 | 11·5 |
| No. 4 ........ | 1·197 | 1·043 | 8·8 | 10·8 |
| No. 5 ........ | 1·195 | 1·041 | 6·0 | 21·8 |
| No. 6 ........ | ·804 | 1·042 | 6·6 | 19·6 |
| No. 7 ........ | ·758 | 1·043 | 8·8 | 10·8 |

*Average for the month of January.*

| | |
|---|---|
| Sugar ...... | 7·8 per cent. of roots. |
| Salts ........ | 13·6 per cent. of the sugar. |

Taking the averages only, the results may thus be summed up:—

| | Lot. | Sugar per cent. of root. | Salts per cent. of sugar. |
|---|---|---|---|
| Beetroots from Vincennes.. | No. 1 | 13·3 | 3·9 |
| | No. 2 | 15·4 | 3·6 |
| | No. 3 | 14·5 | 2·6 |
| Beetroots from ordinary culture .... | | 7·8 | 13·6 |

The crops. of these rich beetroots varied between 40 to 50·000 kilogrs. of roots per hectare.

These remarkable results were obtained by manure of the following formula.

| | Per hectare. |
|---|---|
| Soluble Phosphoric Acid ........ | 80 to 100 kilogrs. |
| Nitrogen .................... | 80 ,, ,, |
| Potass ...................... | 100 ,, ,, |
| Lime ...................... .. | trace. |

It is then evident that neither with mineral manure alone, nor with potassic manure alone, can effects so splendid be obtained but only by the use of carefully prepared chemical manure in which the fertilizing agents can be proportioned according to the requirements of the plant to be cultivated, and according to the products to be extracted from it. And that it is this manure which must be resorted to so as to increase the production of sugar to the advantage both of the cultivators, the manufacturers, and the consumers.

# ON THE INFLUENCE OF FORESTS ON RAINFALL.

### By Alfred Fryer.

(Continued from page 142.)

The injury to the climate of Africa produced by the destruction of Forests, attracted the attention of *Mr. Moffat*, from whose book, "*Missionary Labours*," pp. 329 to 333, the following extract is made:

"They were wont to tell us of the floods of ancient times, the incessant showers which clothed the very rocks with verdure, and the giant trees and forests which once studded the brows of the Hamhana Hills and neighbouring plains. They boasted of the Kuruman and other rivers, with their impassable torrents, in which the Hippotomi played, while the lowing herds walked to their necks in grass, filling their *makukas* (milk sacks) with milk, making every heart to sing for joy. It was in vain that we endeavoured to convince them that the dry seasons had commenced at a period long anterior to the arrival of the missionaries. Independent of this fact being handed down by their forefathers, they had before their eyes the fragments of more fruitful years in the immense number of stumps and roots of enormous trunks of *acacia giraffe*, when now scarcely one is to be seen raising its stately head above the shrubs: while the sloping sides of the hills, and the ancient beds of rivers plainly evince that they were denuded of the herbage which once clothed the surface. Indeed, the whole country north of the Orange river, lying east of the Kalagare desert, presented to the eye of a European, something like an old neglected garden or field. As however, the natives never philosophized on atmospheric changes, and the probable causes of the failure of the plenteous years, they were not likely to be convinced such could depend on anything done by man, even though they were credulous enough to believe that their rain-makers could charm or frighten the clouds into showers, or that our faces or prayers could prevent their descending.

"When reference has been made to certain trees, especially the milkwood, and a few shrubs which they prohibit being touched with a knife or an axe when the rain is expected, I have embraced the opportunity of trying to convince the more intelligent that they themselves were the active agents, in bringing about an entire change of atmosphere. The Bechuanas, especially the Batlapis and the neighbouring tribes, are a nation of levellers, not reducing the hills to comparative plains, for the sake of building their tents, but cutting down every species of timber, without regard to scenery or economy. Houses are chiefly composed of small timber, and their fences of branches and shrubs. Thus when they fix on a site for a town, their first consideration is to be as near a thicket as possible. The whole is presently levelled, leaving only a few trees, one in each great man's fold, to afford shelter from the heat, and under which the men work and recline.

"The ground to be occupied for cultivation is the next object of attention; the large trees, being too hard for their iron axes, they burn them down by keeping up a fire at the root. These supply them with branches for fences, while the sparrows, so destructive to their grain, are thus deprived of an asylum. These fences, as well as those in the towns, require constant repair, and indeed the former must be renewed every year, and by this means the country for miles around becomes entirely cleared of timber; while in the more sequestered spots where they have their outposts the same work of destruction goes on. Thus, of whole forests, where the giraffe and elephant were wont to seek their daily food, nothing remains.

"The natives have also the yearly custom of burning the dry grass, which on some occasions, destroy shrubs and trees even to the very summit of the mountains.

"To this system of extermination may be attributed the long succession of the dry seasons.

"'The felling of forests has been attended in many countries by a diminution of rain, as in Barbadoes and Jamaica. For in tropical countries, where the quantity of aqueous vapour in the atmosphere is great, but where, on the other hand, the direct rays of the sun are most powerful, any impediment to the free circulation of air, or any screen which shades the earth from the solar rays, becomes a source of humidity; and whenever dampness or cold has begun to be generated by such causes, the condensation of vapour continues. The leaves, moreover, of all plants are alembics, and some of those of the torrid zone have the remarkable property of distilling water, thus contributing to prevent the earth from being parched up.'* This was a philosophy, which the more acute thinkers among the people could partially comprehend, though they could not believe. I do not, however, despair of eventually seeing the whole of the population, some of whom are now commencing the building of stone fences and brick houses, so fully satisfied on this point, that they will find it for their own interest, as well as contributing to the beauty of the country, to encourage the growth of timber, particularly as it is only such as is indigenous which can grow to any extent. To the same cause may be traced the diminution of fountains, and the entire failure of some which formerly afforded a copious supply, such as Griquatown, Campbell, and a great number of others which might be mentioned; and which, according to the established theory of springs, must be supplied by melted snow, rain, dew, and vapours condensed. It has been remarked, that since the accidental destruction of whole plains of the wild olive by fire, near Griquatown, as well as the diminishing of large shrubs on the neighbouring heights, a gradual decrease of rain has succeeded in that region, and thus the subterranean caverns found to serve as reservoirs in the bowels of the earth cease to be supplied, especially when there are no lofty mountains to pierce the clouds, or arrest or condense vapours which float in the atmosphere."

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* *Phil. Trans.*, Vol ii, p. 294.

*Dean Stanley*, in his "*Sinai and Palestine*," page 120, makes the following remarks respecting the present barren state of the country :—

"Can these stony hills, these deserted valleys, be indeed the land of promise, the land flowing with milk and honey?" * * * "the country must have been very different when every hill was crowned with a flourishing town or village, from what it is since it ceased to be the seat not only of civilization, but in many instances even of the population and habitations which once fertilized it.

"'The entire destruction of the woods which once covered the mountains, and the utter neglect of the terraces which supported the soil on steep declivities, have given full scope to the rains, which have left many tracts of bare rock, where formerly were vineyards and cornfields.'* It is probable too that, as in Europe generally, since the disappearance of the German forests, and in Greece, since the fall of the plane trees which once shaded the bare landscape of Attica, the gradual cessation of rain produced by this loss of vegetation has exposed the country in a greater degree than in early times to the evils of drought. This at least is the effect of the testimony of the residents at Jerusalem within whose experience the Kedron has recently for the first time flowed with a copious torrent, evidently in consequence of the numerous enclosures of mulberry and olive groves made within the last few years by the Greek Convent, and in themselves a sample of the different aspect which such cultivation more widely extended would give to the whole country. The forest of Hareth and the thick-wood of Ziph in Judea; the forest of Bethel; the forest of Sharon; the forests which gave their name to Kirjath-jearim, 'the City of Forests,' have long disappeared. Palm-trees which are now all but unknown on the hills of Palestine, formerly grew, as we shall presently see, with myrtles and pines on the now almost barren slopes of Olivet; and groves of oak and terebinth, though never frequent, must have been certainly more common than at present. The very labour which was expended on these barren hills of Palestine in former times, has increased their present sterility. The natural vegetation has been swept away, and no human cultivation now occupies the terraces which once took the place of forests and pastures."

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* "Dr. Olin's Travels in the East," vol. ii., p. 428.

The change in the climate of Arabia is thus alluded to in a review of the "*Desert of the Exodus*," which appeared in Harper's Magazine:—

"It is clear that in the course of the centuries since the exodus, the region of Sinai has changed for the worse, and that in accordance with natural laws the existence of which is fully recognized. The region was once a well wooded one, whereas now a single great tree is a notable object. This fact is evinced by the remains of great mining operations, mainly for copper, once carried on here. The copper for the implements of the old Egyptians came mainly from the 'desert' of Sinai. Over and over again the explorers came upon huge heaps of 'slag,' the refuse of great smelting-works long since vanished. These heaps of slag imply a former abundance of fuel, and this fuel could consist only of wood growing in the region; for this was the only fuel that could be employed, and this could not possibly be conveyed to any great distance.

"The argument runs thus:—These heaps demonstrate the former existence of great smelting-works and these works imply a wooded region. Then, as now, we may grant that the peaks were bare, but their lower sides and the valleys were clothed with forests. Any man who has seen how in a few years a single furnace eats up the forests for miles around in order to gain its supply of fuel, understands the whole story as to how the entire character of a region may be thus changed in the course of years. Trees, as we are now coming to understand, play an important part in the economy of nature. They furnish natural barriers against sudden floods. Their roots penetrating the soil form a sort of sponge, which absorbs the rain-fall, causing it to pass off gradually instead of in a sudden torrent, sweeping away the soil. In the admirable work of Elysée Réclus on 'The Earth,' are some paragraphs in which this idea is set forth in respect to the Alps; they would apply with still greater force to the region of Sinai. The Chinese, from whom we still have much to learn, understand this. They maintain groves all along the courses of their rivers and canals.

"Besides acting as regulators, forests have much to do in deciding the absolute amount of rain-fall. The cool foliage of a great tree condenses the atmospheric moisture which would otherwise pass on with the aerial currents. Nothing in physical geography is better established than that the destruction of forests in any region diminishes the amount of rain-fall, and that fertility depends essentially upon this. 'To cut down the trees' was, among the Greeks, the phrase to designate the permanent devastation of a region. It is the destruction of forests more than any other one thing, which has within a few centuries transformed the African shores of the Mediterranean, once a granary of the Roman Empire, into a desert."

The importance of preserving woods is well known to nations that we are too apt to consider half barbarous.

*Captain O'Sullivan* informed the writer that he visited Japan two years ago, and that in that country the steepest hills are regularly planted up to their very summits, and that so important is the maintenance of this mass of vegetation considered, that the mere act of cutting down a tree without planting another, is a crime punishable with death. He also stated that in certain provinces in China the destruction of trees is illegal; and that there wells are sunk in great abundance in order to supply water for the purposes of irrigation.

Attention has been directed to the need of preserving timber in our own colony of Hong Kong, and Sir R. McDonald, the governor, since his visit to Japan, has forbidden even the mutilation of trees. Injury to them or destruction of them is visited by a fine of one hundred dollars inflicted upon the arboricide.

*Captain Arrindell* states that when the Mormons settled in Utah, they found the district almost as barren as the Sahara. Water had to be brought almost incredible distances in wooden pipes. Trees were forthwith planted and carefully nourished with the water so brought, and now the district may be termed "the garden of the world," and it is no longer dependent upon water brought from a distance, but enjoys a steady rain-fall.

The same authority states that certain American local governments grant a bonus for the establishment of a certain number of trees.

## ON THE MANUFACTURE OF SUGAR FROM THE SUGAR CANE, AND THE MACHINERY EMPLOYED THEREIN.

### Part XV.

We have next to deal with the various methods of draining or "curing" sugar.

In a former paper we explained that in the crudest method of sugar manufacture this was accomplished by piercing holes in the bottom of the hogshead, partially stopping these with the stem of a plantain leaf, and then filling them up with sugar from the coolers, the molasses being allowed to find its way out through the holes as it best can. Of course this operation is very slow (the hogsheads are usually allowed some three or four weeks to "cure"), and very inefficient. The various parts of the hogshead are very unevenly drained, and even the best cured portions are far from being dry. On the better managed estates it is usual, when the drainage is supposed to be complete, to take out the better drained portions of the sugar, and repack them in fresh hogsheads, leaving the portions of sugar from the bottom of the hogsheads, which of course are most saturated with molasses, either to be re-cured or to be also packed together and kept apart. This system effects a considerable saving in the loss by leakage during transport, which even when thus reduced is very serious. The great length of time required for this method of draining, the large space consequently occupied by the curing-house, and the imperfection of the process, early led to a search after improved means of separating the molasses from the sugar.

Various arrangements of pneumatic apparatus were first devised for this purpose. The sugar was placed in a form or mould, having a perforated bottom, which was placed in communication with an air-pump. Thus a vacuum was formed below the sugar, while the full pressure of the air was exerted upon its surface. The crystals of sugar were themselves unable to pass through the perforations, but the air striving to find its way through the mass, and to rush into the vacuum, forced the molasses before it. The general results obtained were not, however, very satisfactory. Though the operation was rapid, and though "free" and large grained sugars were thus drained fairly well, the process was not found suitable for small-grained clammy sugars. Indeed when the air has once found a way for itself through the crystals its power of removing any molasses which may yet remain in the sugar is very much reduced, so that the action of the process is uneven. Many patents have been taken out for different arrangements of pneumatic pan, from that taken out by Mr. Hague in

1816, up nearly to the present time, but at no time did this process find any considerable number of adherents.

Later on, the centrifugal machine appeared in the field. This apparatus, which was at first only employed in drying textile fabrics, such as cotton and woollen goods and yarns, was soon applied to sugar, and from that time to the present its use as a means of curing crystallized sugars has been continually extending. It depends for its efficiency upon the centrifugal force developed by rapid revolution. The most familiar instance of the application of this power is the trundling round of a mop, in order to dry it.

As the centrifugal force is proportional to the diameter of the revolving cylinder and to the *square* of the number of revolutions, while centrifugal machines frequently revolve some 1,000 or 1,200 times per minute, it may be imagined that the power thus obtained is very great. Thus, for example, a pound weight at the periphery of a centrifugal basket 40 inches diameter, making 1,000 revolutions per minute will become developed into something like five hundred weight.

A centrifugal machine then consists of a revolving basket or cylinder, in which the sugar is placed, and of suitable arrangements for supporting and giving motion to this basket, for stopping it, and for collecting and conveying away the molasses which drains from it. The periphery of this revolving basket is lined with wire gauze, or finely perforated metal. As it is put in motion the mingled mass of sugar and molasses spreads itself evenly over this perforated periphery; the fineness of the perforations effectually prevents the escape of the crystals, but as the speed increases the molasses has an ever increasing tendency to flow away. This tendency may be increased by the use of a steam jet, either inside or outside the apparatus, which by heating the molasses increases its fluidity, and also dilutes it, by the mingling of the condensed steam with it. Either this application of steam or the use of a little pure water, to wash the sugar, is usually necessary to effect the entire removal of the molasses from the crystals, as the last portions of it usually adhere so tenaciously that they can only be washed off.

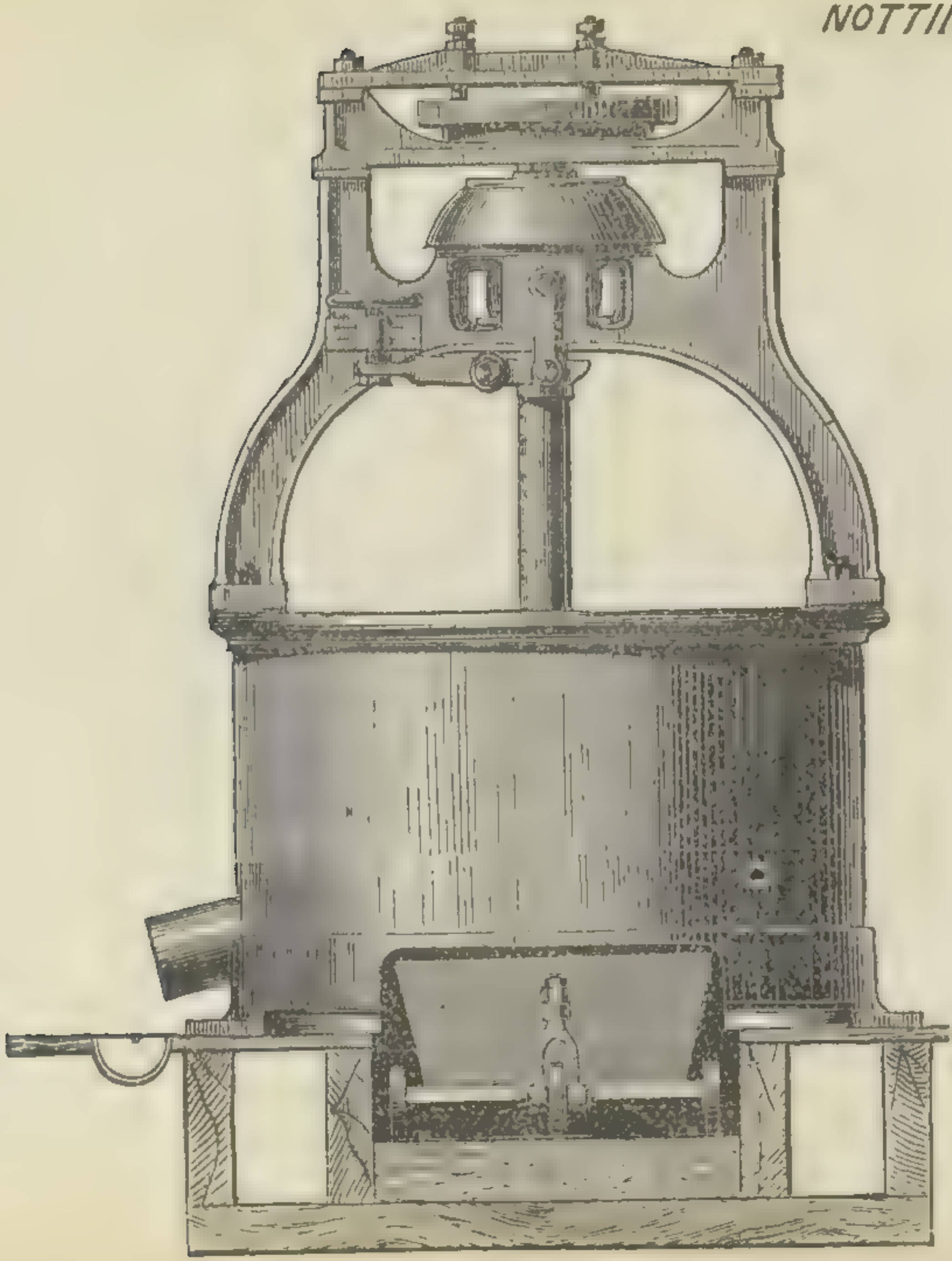


Fig. 5.

MANLOVE ALLIOTT & Co.
NOTTINGHAM

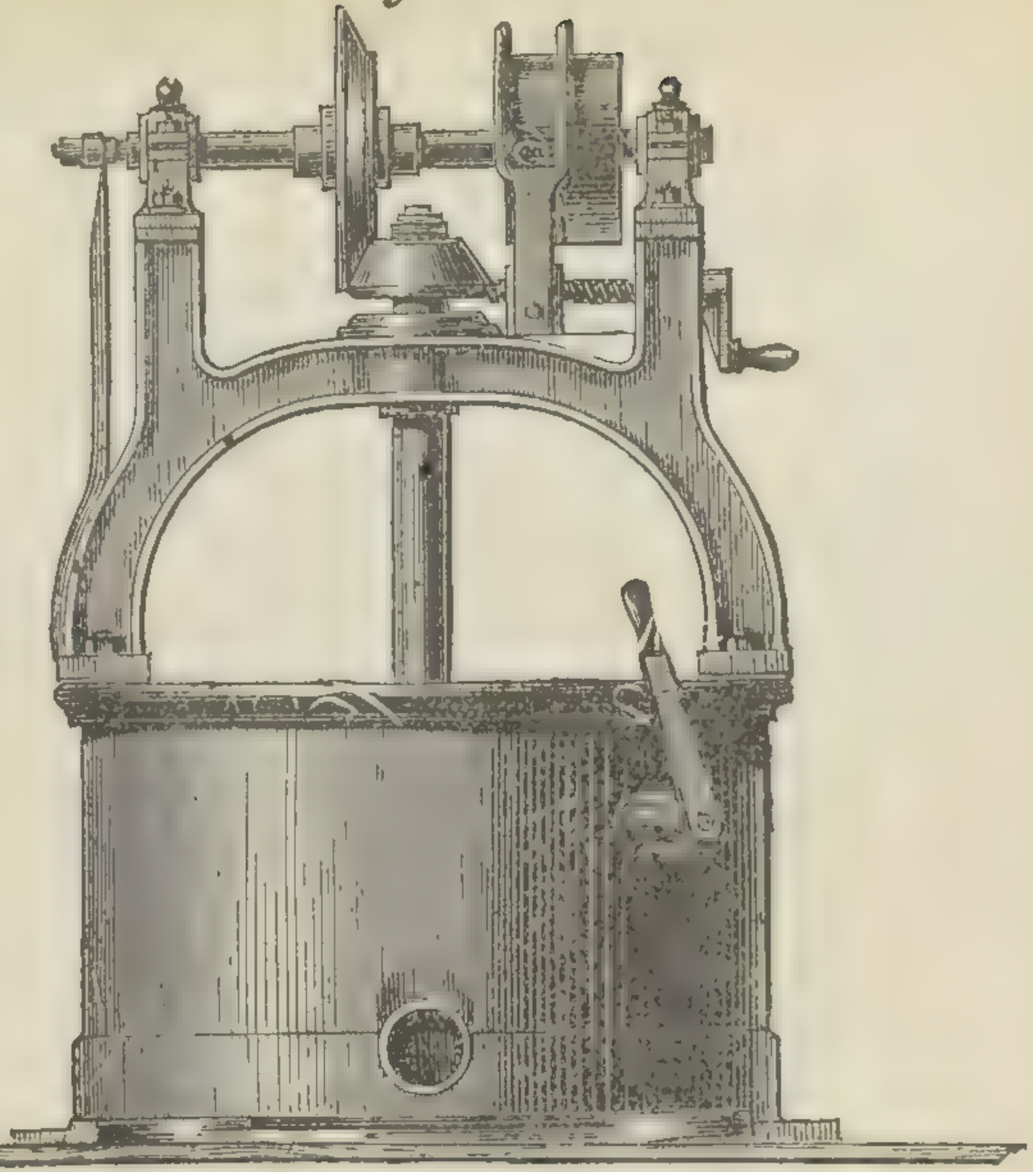


Fig. 1.

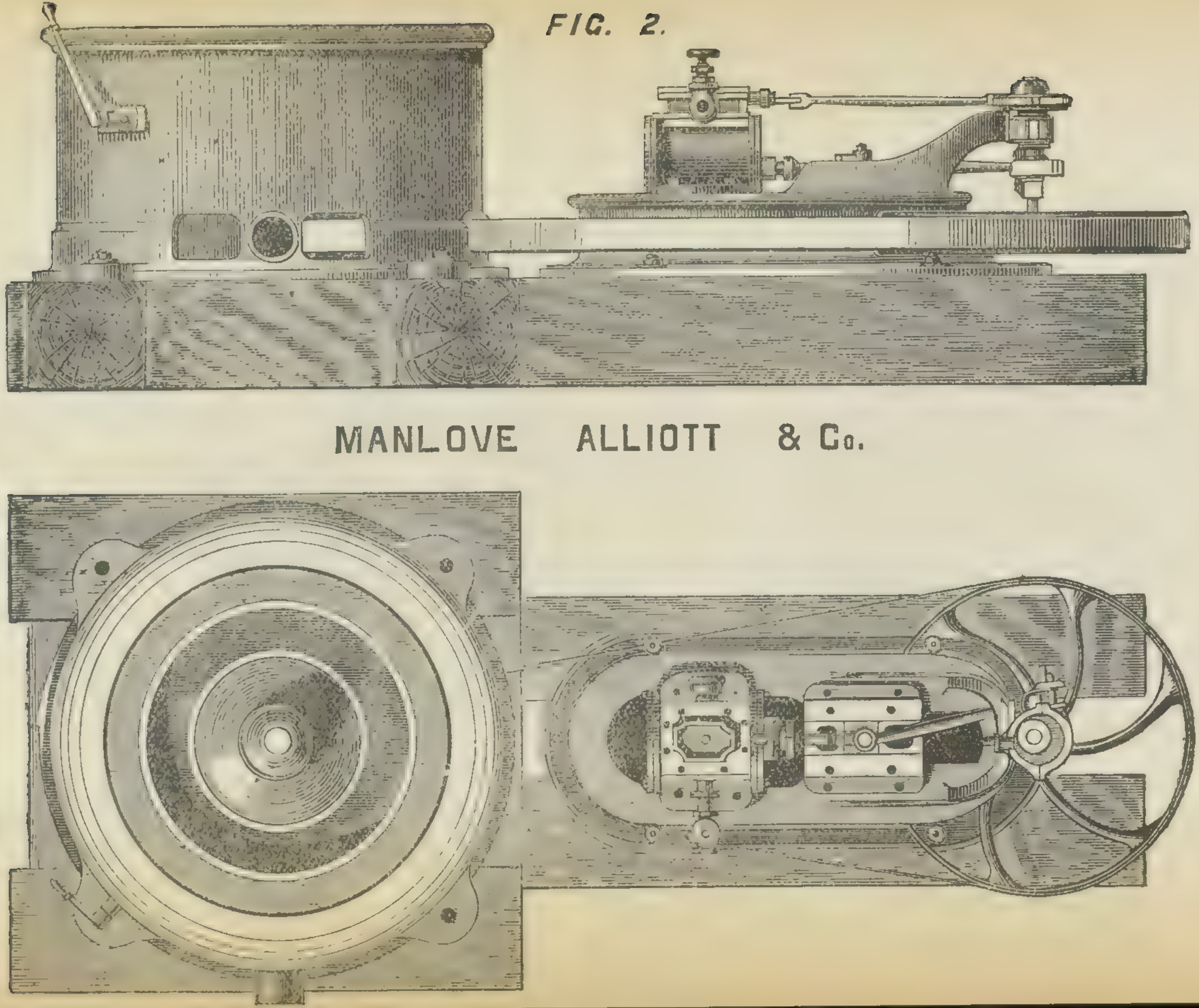
The time occupied in drying a charge of sugar in the centrifugal varies much, according to the speed at which the machine is run, and the quality of the sugar operated upon. A fine open-grain sugar will be dry almost before the machine has attained its full speed, while a very sticky sugar may be much less efficiently dried after remaining in it for half an hour.

From what we stated above respecting the laws relating to centrifugal force, it will be observed that this force is more intense (in other words, the draining power of the machine is greater) when the number of revolutions made by the machine is great, even although its diameter may be comparatively small, than when the diameter of the machine is increased, but the number of its revolutions diminished.

Centrifugals are made of many different forms. At first the driving gear was usually placed above the machine, and although this arrangement has been almost entirely abandoned in this country in favour of simpler ones, it is yet retained almost universally in France, and pretty generally in many other parts of the Continent. Fig. 1 represents one of the best arrangements of this type of machine. It will be observed that in this sketch the machine is shown provided with pullies on the horizontal shaft, by which motion is given to the apparatus. This arrangement may, however, be varied by bolting an engine to the side of the machine, and making this horizontal shaft serve as the crank shaft of the engine. This forms a very compact arrangement, but it does not avoid the defects inherent in machines driven from above, viz., that they are more likely to get out of order and give trouble, and less cleanly than the simpler machines, and that the driving gear, being directly over the revolving basket, is in the way of the workmen.

To obviate these inconveniences, the arrangement of under driven machine, illustrated in Fig. 2, was introduced. In this machine the wearing parts are reduced to a minimum, the driving apparatus being entirely disconnected from it, and the whole machine brought into its simplest and most compact form, while there is nothing above the cylinder to impede the men in working

FIG. 2.



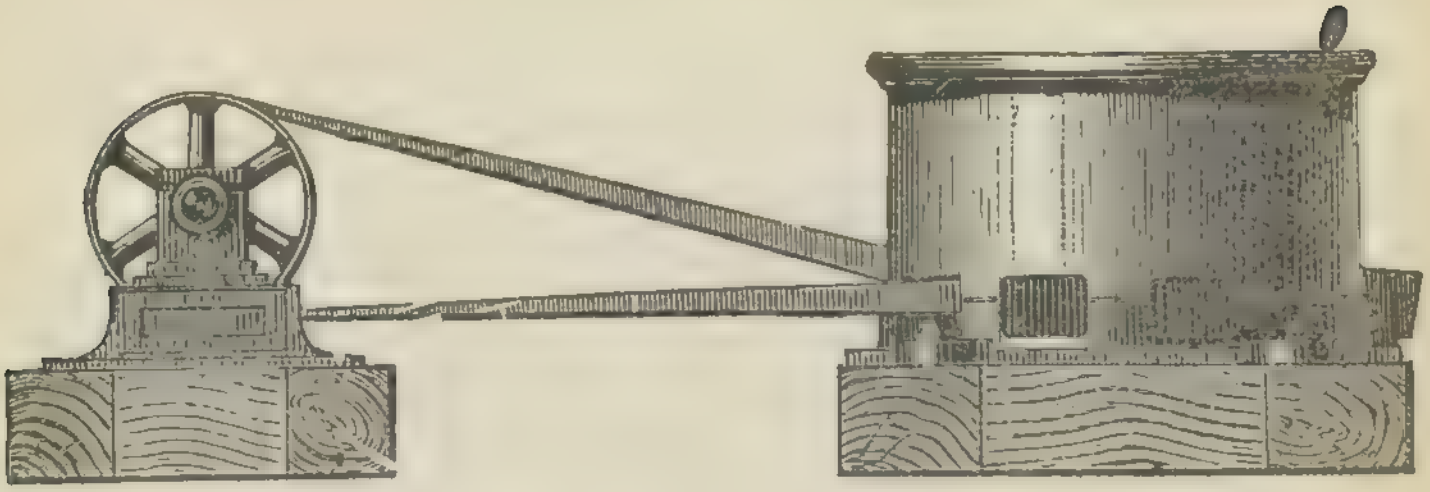
it. In Fig. 2, each centrifugal is shewn driven by a small engine of its own. This method of driving is often found to be very convenient, as the centrifugals can thus be worked independently of all other machinery, save the steam boiler; while in most cases it is less costly to provide each machine with its own engine than to put up a large engine to drive a number of centrifugals together with all the shafting, belting, and counter-gearing which then become necessary.

Where it is more convenient to drive the centrifugals from shafting, it is usually necessary to interpose some sort of counter-gearing to enable the requisite speed to be attained. This counter-gearing may either be of the form shown in Fig. 3, where mitre wheels are employed for the purpose of changing the horizontal into the vertical motion, or of that shewn in Fig. 4, where the same end is attained by giving a half twist to the belt leading from the counter-gearing to the centrifugal. This latter style of counter-gearing requires careful erection, as when carelessly put up, the belt is liable to run off; but when well erected, it possesses the advantage of being perfectly noiseless.

At one time centrifugals were introduced in which the shaft carrying the cylinder was horizontal instead of vertical, but these never found very extensive favour.

Of late years the "suspended" centrifugal has been brought into notice. The various arrangements of suspended centrifugal all seek to avoid the evils consequent on uneven loading by leaving the cylinder free to find and revolve around its own centre of gravity. The first machines constructed upon this principle were, we believe, those used by Mr. Thomson in India nearly thirty years ago. Some eighteen or twenty years ago a number of suspended machines were manufactured by Messrs. Manlove, Alliott and Co., of Nottingham, for the Sankey Sugar Company, in whose refinery they have been working very satisfactorily ever since. These were the first suspended machines used in this country, but at that time it was found impossible to bring them into more general use.

Within the last few years, however, this style of machine has



MANLOVE, ALLIOTT & Co NOTTINGHAM.

Fig. 3.

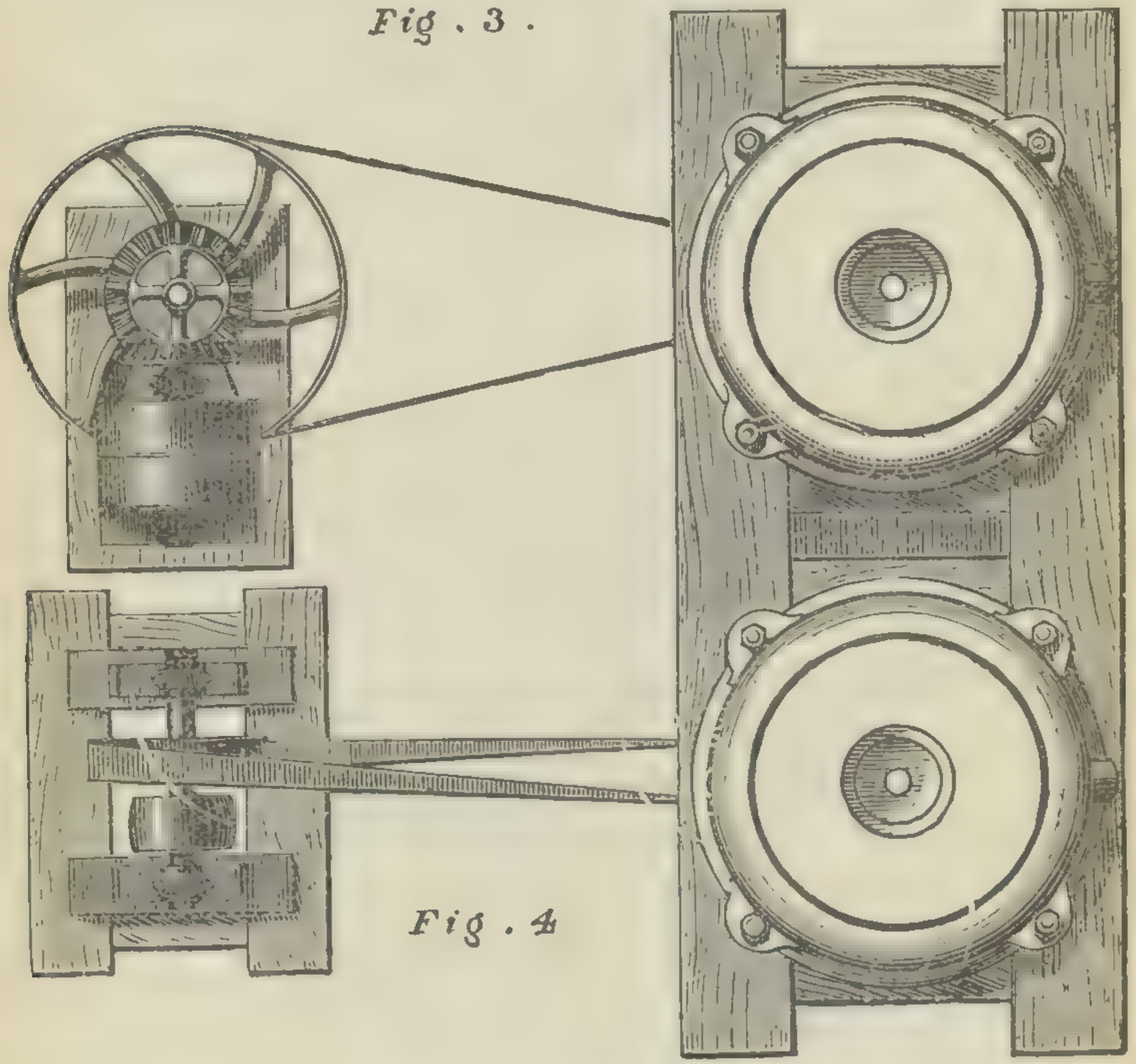


Fig. 4

found considerable favour in America, where various patents have been taken out for different modifications of it. It is usually made to unload through the bottom, thus effecting some saving in labour, but this advantage may also be obtained with any but the smaller sizes of ordinary centrifugals.

It is claimed for it, too, that it can get through more work than the same size of machine of the ordinary construction. If this be so, it is probably due to the fact that it is generally arranged to run at a higher speed than is usually adopted for the ordinary machines. It is also said to consume less power.

It is, however, considerably more costly than the ordinary machine, it is more complicated, and on account of being run at a higher speed, is more likely to do harm should it get out of order.

Fig. 5 shows a good modern arrangement of suspended centrifugal.

Very many arrangements of self-unloading centrifugals have been patented at different times, all having for their aim the avoidance of the delay occasioned by having to stop the machine in order to unload it and load it again.

Though very much ingenuity has been shewn in some of these arrangements, they have none of them proved commercially successful, nor is it likely that an efficient self-unloading machine will ever be introduced.

Necessarily, any such arrangement introduces additional complication and weight, and, in a machine exposed to such severe strains as the centrifugal is subjected to, these are great evils.

## IMPROVED METHOD OF SUGAR CULTIVATION IN JAMAICA.

By Mr. Charles Melville.

(*Continued from page* 190.)

Now, as to the alternative system of transporting the canes to the mill by means of tramways—and by the word tramways I mean to include railways laid on the surface, wire tramways, and the single rail system lately patented, and seeming to me to deserve attention. With respect to the construction of the way itself, in the case of railways laid on the surface, wire trains being quite independent of any road; in the first place a narrow road only would be required, and the difference in cost between a road of eight feet in width and of eighteen needs no comment. Then having once been properly laid, the repairs would be of the most trifling description, the wear and tear being confined to the narrow footway between the rails where the mule walks, the road itself not being exposed to those causes operating to destroy a common road, such as friction and the cutting and grinding actions of the wheels; moreover, the sinking of the road would be prevented, as the weight instead of being thrown alternately on a few square inches (as is the case when a loaded wain passes over an ordinary road) is distributed, on account of the connection between the rails and sleepers over a large area quite sufficient to sustain the weight passing over the line. As to the durability of the rails themselves, they may be said to be everlasting, as with the greatest amount of traffic likely to pass over them, they would certainly last for a lifetime. I have in my mind an instance of a portion of a line of rails over which had passed for ten years the canes to make an average crop of 400 tierces, having been found at the end of that time to have lost an inappreciable amount in weight.

Sleepers can be procured of durable woods, and at a trifling cost, the average duration of which may be taken at from six to ten years. The repairs to embankments and cuttings from stress of weather would of course be in proportion to its width, but having the use of the trucks to carry material, cheaply performed, so that the whole outlay may be said to consist of the first cost and expense of laying, the usual charge for repairs falling far within what is now paid for repairing ordinary roads.

With respect to the motive power, supposing animals to be used, it is a well ascertained fact, that where 10 cwts. can be moved over a well constructed road, 10 tons can be moved with the same power over a well constructed tramway; so that the motive power required may be safely stated at one-sixth that now employed.

The amounts now paid for repairs to vehicles may be struck off the bill, as the truck wheels being of iron would last as long as the rails, and the trucks would not be exposed to those shocks and strains which wains now have to endure.

As to the working of the trucks, any moderately intelligent man would soon learn to manage and control them, and for this purpose the coolies would be found valuable, as they are active, intelligent, and careful. Moreover, one man would suffice for each truck, whereas now two men of a class difficult to be obtained are required for each wain.

With respect to the facility for removing the canes from the fields, the tramway would be no whit behind the wains, as it is impossible to send any cart into the field without seriously injuring the cane stole; and in consequence of this, and because many of the cane fields are inaccessible to trains, recourse has now to be had to winding off the canes. But short lines of temporary tram can be laid to most of the fields, and where from drains or other obstacles they cannot easily be put, the wire tramway or single rope "calese"* affords the means of getting the canes from the field with ease and rapidity.

Finally, the whole process can be placed so perfectly under control that no danger need arise to man or beast; also the road once laid no limit can be placed to its capability for supplying canes to the mill, this merely being a question for a few more trucks and a few more mules.

To sum up the advantages of this system:—The comparative cheapness of the road itself when compared with good ordinary roads, and moderate outlay required for repairs; the release of five-sixths of the stock now required for cartage; the less amount of labour required; the saving of repairs to vehicles; the saving of life and limb to man and beast; the perfect control of the whole system, and its unlimited capacity to supply canes required. Against the savings to be made under these heads, put the prime cost of the road charges, interest on the capital expended, and I venture to say that in a short time the money will be saved, and the estate benefited to an extent that would justify a much larger outlay.

Now the loss from canes having been planted and brought to maturity to rot, will be avoided. Should a system of tramways be adopted, as I have endeavoured to show, and all other things being equal, viz., machinery in good order, and capable of reaping the crop in time, no further loss from this cause need occur.

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* "Calese," a rope with a running pully, to which bundles of canes are hooked.

The small yield of clay lands arises, as I have pointed out, from want of sufficient tillage, and I would apply the cattle that are released from the cartage of canes to this, as I consider it, legitimate purpose.

The value of a thorough system of ploughing does not need my advocacy; but as to the general plan I would pursue, it may not be amiss to say a few words. And first I would insist upon the necessity of a thorough close ploughing of the clay, to be followed by a harrowing, by means of which the soil will be broken up and exposed to the influence of the sun and air, and rendered pervious to the roots of the cane and the rain. It would then be necessary in some instances, though not in all, to open a light furrow for the reception of the tops, and this more for the arresting of the wash on hill sides than from any benefit to be derived from the practice of banking the cane up. This preparation of the land could be performed at a greatly less cost than is now incurred by the miserable system of digging cane holes, and the benefit that the cane would derive from being planted in a soil in which it *can* grow, and where its roots will be able to reach and feed upon the stock of food contained in the soil, and upon any manures that may be employed, cannot be over estimated; and I do not doubt that this yield of canes per acre would be greatly improved.

Another great advantage to be secured by preparing the land with implements, is the fact that we should be rendered independent of that array of cane-hole diggers who enrich themselves at the expense of the estate for a few months each year, retiring to their small holdings for the rest of the season, and cannot be persuaded to perform any other description of labor at any price which the unfortunate proprietor can afford to offer them.

But we must not stop here if we are to insure a good ratoon from the canes planted in this properly prepared land. If left to itself the rain will again consolidate and the sun bake it, until by the time the young ratoon is covering the land (if it ever advances so far) it more resembles brick than any mould suited for the plant to thrive in.

Its state of health must be maintained by means of the subsoil and light plough, worked by mules, until the plant has fairly covered the ground, and this treatment must be again commenced as soon as the cut cane has been removed, and continued until the ratoon has in like manner covered the land; the plant will then be at all stages of its growth, in a position to derive full benefit from manures.

Another benefit to be obtained from what I will term "secondary tillage" will be the absence of weeds, indeed this effect of thorough stirring of the soil is so well known where crops are planted that it would be impossible to weed, such as wheat, that no seed is ever sown until the weeds have been eradicated by ploughing, harrowing, and raking; and experience has shown that the same result may be obtained in cane cultivation, where a thorough system of mule plough tillage is pursued. For this purpose there should be a number of good mules, and a variety of implements (ploughs, subsoil and light mould grubbers and cultivators), kept constantly at work. As it is well known that the labor necessary for the weeding of the canes is very unreliable, and at some seasons impossible to be procured; and as it is likewise well known that the greatest enemy of the cane is grass, it seems hardly necessary for me to point out what an advantage it would be to adopt a means requiring a minimum of manual labor to perform the necessary labor of keeping the canes clean. That the attainment of this object is practicable, I can testify from my own experience, and I have no doubt I shall be borne out in my assertions by other practical men. The means above spoken of for increasing the yields of lands, abolishing to a great extent manual labor, and doing away with the necessity for maintaining a large herd of oxen, will have the effect of reducing the expenditure, and thus prevent the loss of money spent for no adequate return. And I especially press the point of an extended system of mule plough tillage, believing that next to the adoption of tramways for transporting the canes, and the release of cattle thereby to perform the preparation tillage, it is the principal improvement required to render these mountain estates more profitable.

With respect to the loss from the inferior quality of the produce made, I am inclined to think that this is doubtful, as I am well informed that there is a steady demand for common process sugars at remunerative rates, and I am aware that the application of highly scientific processes to the manufacture of sugar is attended in remote districts with many drawbacks and considerable expense. But as there can be no doubt that the loss of molasses is great and absolute, I can see no reason why it should not be all extracted on estates. The objections sometimes raised, that from the smallness of the grain of our common process sugar much is lost through the centrifugal machine, might be done away with by the adoption of a patent concentrating pan of some sort, none of which, as far as I am acquainted with them, equal, either for size or firmness of the crystals produced, the Gadesden pan.

Having first stated the general principles that I believe should be adopted to render the cultivation of sugar cane more remunerative, I would only point out that for the improvements indicated I do not advocate the employment of further capital, but only the transfer of that already invested, and what would have in the next few years to be invested, in stock, to the purposes indicated. And I cannot refrain from stating my firm conviction that should we be granted favourable seasons, the savings that will be effected, and the increased production that will ensue from the adoption of the measures proposed, will prove the best support of the ideas here enunciated.

## SIR B. PINE ON CENTRAL FACTORIES.

The Governor of the Leeward Islands confederation has been appointed to the colony of Natal. Before leaving Antigua he addressed the local Council; the following is extracted from his speech:—

"But, gentlemen, the most important subject to which I would invite your attention is the establishment of central or common factories. It is now more than ten years since I tried to call the attention of the people of these Islands to this subject. I pointed out the inexpediency of carrying on, on a single small estate, the business of a planter, of a miller or grinder of canes, of a distiller, and of a shipper of produce; and I pointed to central factories, as then being established in the French Islands, as the ready means of removing the inconvenience.

"This suggestion of mine, after being neglected in these Islands for ten years, at length attracted the attention of some of yourselves, and at your instance I sent a Commission to the French Islands to enquire into the working of the system.

"The report of the Commission was sent to the Secretary of State, and by his Lordship transmitted to the Governors of other sugar growing colonies. The result of this correspondence has been that, as I am very happy to inform you, the Secretary of State has requested me to report to his Lordship whether I can make any definite suggestion for the establishment at the public cost or otherwise of central factories within this colony. To enable me to reply to this request, I wish to avail myself of your knowledge and experience. If I should advise that this undertaking should be fostered at the public charge, I wish you distinctly to understand the grounds on which I should do so.

"We have no right whatever to put our hands into the public purse to aid mere enterprise or to advance the interests of any one class of the community, however important.

"But, gentlemen, I hold that the establishment of these factories would benefit directly or indirectly the entire community without any exception whatever. The effect of it will be to make sugar planting a purely agricultural business, and to enable the present owners of estates to work at far less cost, and to throw open the staple industry of the country to any man whose industry and integrity have given him the means of buying or renting a comparatively small plot of land. Instead then of these Islands being year by year denuded of resident proprietors and becoming mere sugar factories worked by agents for great capitalists in England, a state of things fraught with evil in the present and danger in the future, they will have a number of resident owners and cultivators of different grades of society. A great stimulus would be given to the honest labourer, who instead of looking forward to the poor house as the goal of his toilsome career, would be cheered by the prospect of some day possessing his plot of land gained by his own industry and good conduct."

Sir B. Pine has been credited with capacity as a statesman, but the suggestion in his speech that the Government shall possibly enter upon the business of a sugar manufacturer, will probably astonish his admirers. It is by no means certain that a central sugar factory in a British colony would prove remunerative, and there is not, we believe, at the present time, any such in existence. The success however would be more probable for a private or public company than for a factory established or subsidized by the Government. It is to be hoped central factories will shortly be established, but the injustice of using public money or credit for this purpose, will, it is to be hoped, not be lost sight of.

A central factory will either prove a success or a failure. If a success the gainers will be the vendors of canes in its neighbourhood, and those who have a direct interest in the factory. The planters whose estates were not adjacent, and all the other tax payers, would have no interest or gain in the success of the factory, but would be directly affected by its failure. Thus it would be manifestly unjust to pledge the public credit for the establishment of central factories.

In the reports of the Antigua Commission we fail to observe any calculation that would show what portion of the profits made by the French central factories has been due to the unjust method of levying the sugar duties in France, and what portion has been derived from the operation of the détaxe. In the *Sugar Cane* for for July last, the accidental profit which the French factory thus enjoyed was shown to be 2s. 5d. per cwt., and the recent change in the English sugar duties will raise this amount to 2s. 8½d.

The *Produce Markets Review* of the 5th ult. reports: "Demeraras are now at a price which is satisfactory to all concerned, except to the planters, who complain of their small profits, and threaten to give up crystallized sugar, and to make only Muscovados if present rates continue."

If central factories should be established in British colonies, it will be needful for their promoters carefully to examine and seriously to consider whether it will be more profitable to make a large quantity of an uninjured raw material suitable for the refiner, or a smaller quantity of a greyish grocery sugar, for which the demand becomes less year after year. Present prices of fuel and of machinery, as well as the recent alterations in the sugar duties, will be elements in the calculation which they must take into account.

But whichever system appears the more profitable, they must not expect to obtain public moneys or Government guarantees.

What would Mr. Lowe say to a proposal for the Government to work our collieries, or spin our cotton, with the laudable objects of affording a "great stimulus to the honest labourer," &c., as recounted by Sir B. Pine?

If the retiring Governor had as zealously prosecuted works which lay within the province of his Government, as he now advocates those beyond it, his departure from this land would have been more sincerely regretted by the inhabitants of Antigua. For example, if the roads of the island had been left in a fair condition, a heavy tax would not have been virtually inflicted on the possessor of every vehicle and every beast of draught, which is now the consequence of their heavy wear and tear. If an island postal service had existed, the transmission of every letter would not have entailed the service of a special messenger, and if the same care had been extended to the conservancy of forests that is bestowed in India and elsewhere, a reasonable hope would have existed that the climate would have become more favourable for the cultivation of the staple of the island.

## NEW METHOD FOR THE DIRECT DETERMINATION OF THE AMOUNT OF REFINED SUGAR IN RAW SUGAR.

By Dr. C. Scheibler.

(*Translated from the Journal des Fabricants de Sucre. By H. C. Humphrey.*)

The yield of crystallized white sugar from the raw beet-root sugars is not in direct proportion to their polarimetric analysis. What then are the researches or calculations to be made to determine in a theoretical and preliminary manner the yield of white refined sugar from a raw beet-root sugar?

It was in these terms that the question offered for competition was worded, whose solution I have studied under very different aspects, having recourse at the same time to physical and chemical methods. But of these methods one only, and I speak here of the chemical methods, has answered the hoped-for result. It has led to a process of great simplicity and accuracy, answering in every particular the question propounded.

The other methods of analysis, although furnishing up to this time only negative results, still deserve to be here rapidly examined, for two reasons: first, because I expect to base on these methods my future researches; secondly, because they allow me to show my way of looking at the still debatable question, "the causes of the formation of molasses in the manufacture of sugar." I shall therefore in a few words mention the physical, then the chemical methods which I have used, and finally conclude by describing the details of my process, which I support by experimental data, being persuaded of having thus given the true and complete solution of the question.

### A. PHYSICAL METHODS.

It is an incontestable result of researches recently made in the formation of molasses, first by myself, and continued afterwards by MM. Marschall and Feltz, that the formation of molasses is not due to the salts, as has always been admitted. At the same time, the results of these researches seem equally to demonstrate that the formation of molasses is as little influenced, at least conditionally, by the presence in the raw sugars of salts of organic acids or of neutral organic substances. So the real cause of the formation of molasses remains still enveloped in a dark cloud, and is less explainable than ever.

Now, it seems to be probable that the formation of molasses does not depend in general upon chemical phenomena, properly speaking, but that it constitutes a physical act, which under certain given conditions, opposes itself to the crystallization of the molecules of sugar, and prevents them from precipitating in the solution. A concentrated aqueous solution of chemically pure sugar will deposit its sugar in crystals following the conditions of vaporization or evaporation of the solution, the temperature remaining constant. This process will continue without cessation until the disappearance of the last drop. A mother liquor (molasses) is not here formed, because all the molecules of sugar in the solution are separated one from the other, by distances constantly equal, and because the force by virtue of which they tend to reunite in crystals is never disturbed and remains the same.

There is an entirely different state of things when other elements, foreign substances, non-saccharine bodies, accompany the sugar of the solution. The molecules of sugar by reason of the presence of intervening molecules of a different nature will be separated from each other by greater intervals, and will no longer be able to obey with the same energy their reciprocal force of attraction; their crystallization will be slower. If we now eliminate from this solution of mixed molecules the crystals of sugar, the molecules not composed of sugar remaining in the molasses, it is clear that the molecules suffer a separation more and more considerable, which at a certain limit will render them incapable of exercising their reciprocal attraction efficaciously; crystallization of sugar no longer takes place, molasses is formed.

In regard to foreign substances, salts, which likewise are crystalline and separate, they cannot be considered as substances capable of forming molasses, a peculiarity to which I have first drawn attention when I said—"All the principles, contained in the juice of the beet, and possessing the property of crystallizing, ought not to be classed as substances tending to the formation of molasses; there are, on the other hand, substances which do not possess this property." Hence the conclusion that these elements of the juice are incapable of crystallizing, becoming by boiling thicker and more viscous, and at last causing the whole mass to lose its mobility to such an extent that the arrangement, or a crystalline juxtaposition of the sugar molecules is disturbed; they are separated and cannot reunite.

Nitre and Glauber salt crystallize independently and in presence of sugar. These are then the salts which cannot be included amongst molasses-producing substances. From this we get the explanation of the fact that the sugar of the molasses begins to crystallize as soon as a part of the foreign bodies is eliminated, by whatsoever means, as, for example, osmose. The molecules of attraction approach each other, their force of attraction increases in consequence, and they reunite in crystals.

It is from analogous circumstances that the mobility of the molecules of sugar, and consequently their capacity to crystallize, will be diminished according as the intervening foreign substances are possessed of a more syrupy, more viscous, or thicker consistency.

It is known that certain molasses can give up crystallized sugar when they are submitted to a higher temperature, that is to say, in rendering their foreign substances more mobile. The direct experiments of the above-mentioned chemists also show that the salts (principally organic) which give thick solutions, play the role of molasses-producing substances.

These considerations have given rise to the hypothesis which may be used to measure the molassigenic value of a raw sugar by the viscosity and thick consistency of its solution. It can be admitted then that of two distinct samples of sugar, both having the same amount of sugar, the one giving the thick solution will be in refining the richer in molasses. The degree of consistency may be compared to those of solutions of chemically pure sugar, the temperature being taken into account.

In applying myself to these considerations, I have made a number of experiments, endeavoring to determine, by following very different processes, the degree of consistency of pure and impure sugar solutions.

1. Determination, with observation of temperature, of the time taken by different solutions of raw sugar of equal volumes in flowing from a capillary tube under constant pressure in comparison with equal volumes of chemically pure sugar. The remarks of Poiseuille* and Graham† on this method of investigation raised hopes of satisfactory results, in applying it to the object of this work, that is, that the time which it takes for sugar solutions holding different foreign substances to flow from a capillary tube, is a means of measuring their degree of viscosity or gumminess, and of showing their molassigenic quality.

2. Determination of the duration of oscillation (*a*) of a magnetic

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* Mein., Savents étrangers, ix., p. 433.

† Liebig's Annalen, vol. 123, p. 90.

needle, vibrating freely in the sugar solutions; (*b*) of a pendulum suspended by a double thread and producing horizontal oscillations, which are registered by an electro-magnetic pointer.

3. Determination of the size of the drops of pure and impure sugar solutions, by letting fall upon a small spherical surface a certain number of these drops, whose weight is determined. It had been proved that thick viscous solutions produce the largest drops, and consequently the heaviest.

4. Determination of the refracting power of pure and impure sugar solutions whose proportions of sugar are known.

All these methods, it is true, have not resulted in an easy process for the determination of the value of raw sugars according to the sense of the question proposed by the jury; but they offer, nevertheless, other interesting results, and perhaps such as are susceptible of application, which I propose discussing hereafter with greater detail, as soon as I shall have finished the series of investigations which it is necessary for me first to pursue.

### B. Chemical Methods.

Starting with the idea, in the first place, that there are foreign organic substances in raw sugar which are the cause of the formation of molasses, I am busy in finding the most direct method of estimating them. Such a method we still actually need, and if we obtain the per cent. of these substances, it is only by means of a centesimal analysis, and from results reckoned by difference, figures rendered doubtful by all the arithmetical errors of the other preliminary analysis. Yet, although it will probably be impossible to establish any really perfect analytical process for the determination of the organic substances, not consisting of sugar, except by means of properly called elementary analysis, which is too long and tiresome for the solution of a purely technical question, I have attempted to find a means of determining these foreign organic substances, consisting in estimating the quantity of oxygen necessary to transform them into their products of combustion, water and carbonic acid. The following are the methods employed:—

5. Determination of the quantity of foreign substances in raw sugar by means of oxidation with permanganate of potash.

Having determined by means of a preliminary analysis the amount of permanganate of potash solution necessary for complete oxidation of a fixed quantity of sugar, there would be so much more of this reagent required for a raw sugar, having the same proportion of pure sugar, as this raw product contained more foreign, non-saccharine, oxidizable organic substances, independently of the sugar. It is therefore by the excess of permanganate used that we will know the amount of oxygen necessary, and it will serve as a means of estimating the quantity of foreign organic substances.

Relying on this method, incontestably exact in theory, I am engaged in discovering a method of titration, which, I must confess, has presented numerous difficulties in practice. The sugar is easily oxidized by the alkaline solution of permanganate, at the temperature of the water bath. Carbonic, oxalic, as well as other acids, as yet little known, are produced.

The reaction completed, it is necessary to render the liquid acid by means of sulphuric acid, and to continue to heat in order to ensure the transformation of oxalic acid into carbonic, as the former remains in the alkaline solution. But here are the difficulties which exist. The weak oxides of manganese, set free, do not dissolve even in an excess of sulphuric acid; then the chlorides, which the raw sugar contains, disturb the reaction in consequence of the disengagement of chlorine. However, I thought I would make mention at first of my analysis, founded on a method of titration of the foreign organic substances, a study to which I hope to return at a future time.

Here ends the series of essays which I have made use of, without obtaining, as I had hoped, the successful solution of the proposed question. I now pass to a detailed account of another process, which I am persuaded will give, in a very simple and practical manner, the solution of the problem.

## SOLUTION.

Process for the immediate determination of the amount of crystalline sugar in raw sugar, by means of treatment with a solution of sugar in alcohol saturated with an acid.

The process in question is not entirely new, for it has already been published, although in an imperfect form, by Payen, in the year 1846, in the *Moniteur Industriel*, No. 1013, and has likewise been described in Dingler's Journal of the same year (vol. 100, p. 127).

It is founded on the principle of treating samples of sugar with saturated solution of sugar in alcohol; this solution dissolves and eliminates the impurities of the sample without in the least acting upon the crystallized portion.

The process, such as described by Payen, could not be rightly recognized in the chemistry of sugar industry, at least I am not aware that it has ever been applied, and scientific literature, to my knowledge, gives no mention of researches or results obtained by this method.

The description of the process according to Payen, given and recalled by me incidentally in a general meeting of sugar manufacturers, in the year 1866 (see *Zeitschrift*, vol. xvi., page 403), did not contribute to call the attention of manufacturers to this fact. In the past few years I have made at different times researches relative to this process and obtained only negative results; and it has happened that the experience of others has been of the same sort, judging from the oblivion into which this process has fallen, from which no one up to this time has derived any important results.

The question for competition proposed by the assembly reminded me of the process, and gave me an opportunity to devote to it a more attentive research. My chief aim was to recognise distinctly, and to seek to avoid the sources of error of this process. The principle on which it rests, the principle which Payen had borrowed from the analysis of nitrate of potash, for a long time in use in the gunpowder manufactories, is perfectly rational. It only remains, in my opinion, to apply it free from every source of error.

Now, as chief result of my comparative labors on this process, I find it necessary to treat the sugars, to be analyzed, successively with different solutions, to watch that these solutions are saturated with sugar, that this saturation remains during the course of analysis, and that the alcoholic solutions are prevented from absorbing atmospheric moisture, or from losing their alcohol by evaporation; all which conditions I have had no difficulty in meeting. It is for these reasons that I have avoided filtering, and washing the crystals of purified sugar on a weighed filter (an operation subject to very sensible errors), and have carried on the operations in closed vessels.

By the exposition of the details of the method to which I have added essential modifications, I will set forth, more clearly than in any other way, the distinctive features of my method, as well as the advantages it possesses over that of M. Payen. Even at this point I am compelled to remark, that I have been in the highest degree astonished and satisfied at the extreme accuracy of the results obtained by the method thus modified, being persuaded that few methods of investigation and analysis will be found to possess so easy and rapid an application and so great precision.

Renewing Boneblack by Acetic Acid.—Prof. Knapp.—The advantages claimed for acetic acid over hydrochloric acid are, that the latter dissolves out quite a large quantity of the calcic phosphate, while the acetic acid only removes that portion of the boneblack which requires removing, and farther, that if the acetic acid be not entirely washed out, it is decomposed by the heat, while any remaining chlorides fuse together and glaze over the surface of the coal. Since iron phosphate is not dissolved by acetic acid, it is necessary to employ the hydrochloric acid occasionally, when the coal has taken up much iron.

Unrefined Sugar.— Out of 150 samples of sugar examined by Dr. Cameron, about fifteen were found to be unfit for use by reason of the presence of acari. It is important to note that the acari have never been found in refined sugar, being wholly confined to the raw or unrefined sugar, which however, almost always contains them. According to Dr. Hassall, sixty-nine out of seventy-two samples of raw sugar bought in London contained these insects. Dr. Cameron recommends that raw sugar should cease to be an article of food and be wholly replaced by the refined article.—*Medical Record.*

## DUTCH MEMORIAL.

*To the Lords Commissioners of Her Majesty's Treasury.*

The Committee of the Sugar Refiners of the United Kingdom beg to draw your attention to the following copy of a Memorial, addressed by the refiners of Holland to the Minister of Finance at the Hague, and to the copy of the answer to that document.

[Translated Copy.]

*To His Excellency the Minister of Finance (at the Hague).*

The undersigned, all sugar refiners of Amsterdam, respectfully beg to make known :—

That with particular interest they have watched the discussions which recently have taken place in the Legislative Assembly in France, respecting the projected modification of the sugar law, in connection with the International Convention of 1864.

It therefrom appears that the saccharimétric, or the chemical analysis of the sugar, is suggested as one of the means to arrive at an equitable levying of the duties, whilst it is asserted that, according to a document in the possession of the Minister of Commerce (in France), said measure likewise is strongly recommended by the Dutch Government, as according to their opinion the most suitable.

Your memorialists, upon this ground, consider themselves called upon by the present to represent to your Excellency, that in the introduction of the saccharimétric towards the aforesaid purpose, they see an insurmountable obstacle, since the experience of many years has shown them that hitherto the saccharimétric does not indicate the exact richness of the sugar, as evidenced by the constantly considerable deviations in the analysis of one and the same sugar sample by different chemists.

Your memorialists consequently regard the introduction of said means altogether impracticable, as, apart from the inseparable waste of time, the trade in colonial sugar, especially in floating cargoes, would thereby be rendered next to impossible.

When they now consider that the present system of classification by colour has proved itself too defective to assure an uniform and equitable assessment of duties, your memorialists are of opinion, that the only other means left to put the refiners in the four countries on one and the same footing would be "refining in bond" (l'impôt à la consommation); but as, with reference to the mode in which the Sugar Convention has been carried out in France, they cannot expose themselves to any impossible competition, they limit themselves to declare by the present, as they already have done on the occasion of the last Congress, held at Brussels, that on "refining in bond" being adopted in France, in England, and in Belgium, with severe precautions against fraud, but without impeding, by vexatious provisions, the free exercise of their industry within the sugar-houses, they then would willingly accept the latter system.

Your memorialists, in conclusion, beg to recommend their interests in this respect to the gracious consideration of your Excellency.

[Translated Copy.]

Department :—

In and Outward Duties and Excise.

*To the Directors of the Netherlands Sugar Refinery,*
*C. S., Amsterdam.*

According to your memorial of the 8th inst., considering the defects of the present system of classification by colour and the difficulties attached to the introduction of saccharimetry, refining under control of the Customs, with levying of the consumption-duties on the produce obtained on its leaving the sugar-house, would be the only means to put the refineries in Holland, Belgium, England, and France upon an uniform footing with respect to the export trade.

On that system being adopted in the last-named three realms with effective precautions against fraud, but without impeding the free exercise of refining within the sugar-houses, you likewise would be agreeable to the same.

Pending the negotiations respecting the International regulation of the sugar-duties, those your declarations, as far as required, will have attention.

Should it thereby be confirmed, that the foundation of the system at present existing is not susceptible of efficient improvement, then the system of refining under control will be made a matter of serious further examination.

Willingly I give you hereby the assurance that, in case the said system should be adopted in this country, every hampering of the industry not needed to secure the Excise duty will be as much as possible avoided.

The question as to what provisions will, in the said system, if adopted, be required to prevent fraud, cannot yet be replied to.

This matter also will be reserved for the consideration of the contracting powers.

We request that Lord Lyons may be asked to draw the attention of the French Government to these documents.

For the Committee of the Sugar Refiners of the United Kingdom,

*(Signed)* **A. W. GADESDEN,**

CHAIRMAN.

## ANALYSIS OF ANIMAL CHARCOAL.

By T. L. Patterson, F.C.S.

The letter of your correspondent "F.C.S." (*Chemical News*, vol. xxvii., p. 104) prompts me to communicate a few observations on the above subject. On a future occasion I hope to go more fully into the composition and analysis of charcoal.

Animal charcoal when new and of good quality contains about 4·5 per cent. of organic matter. A small portion is soluble in water, the greater part is soluble in acid, and the remainder is insoluble in either menstruum. Now, when charcoal is ignited, the loss of weight is equal to the carbon + organic matter + water. Whereas when it is treated with acid, and the insoluble matter collected on a filter, washed, dried, and weighed, the contents of the filter, after deducting the sand left on ignition, consists of carbon and only the small portion of organic matter insoluble in the acid solution. If the result obtained by the ignition method after deducting the water be recorded as carbon, it will be found to be 4 per cent. or so, more or less, than that obtained by solution; because in the first case the total organic matter is included, while only that portion insoluble in acid is recovered in the latter method.

It is the practice of most chemists in analysing animal charcoal to estimate water, carbon, carbonate of lime, sulphate of lime, oxide of iron, alkaline salts and sand, extending the difference as phosphate of lime and magnesia. In my future communication I will endeavour to show how erroneous this is, not only with regard to the organic matter, but also as to another constituent of the char. One of the constituents included in this difference is organic matter, which I believe ought to be always accurately and separately determined, since it not only enhances the value of the analysis, but gives important information as to whether the char has been properly burned. Thus when the organic matter amounts to 5 per cent., it may be taken as an indication that the char has not been long enough burned, or high enough heated in the process of its manufacture. And, conversely, when it falls much below 4 per cent. it is likely the sample has been over-burned. Home-made char is sometimes under-burned, while that of foreign origin is as often over-burned. Of the two evils under-burning is the least.

Having during the last five or six years analysed a great many samples of charcoal from various sources, and having invariably determined the organic matter contained therein, I may say as the result of my experience that in new charcoal it amounts to between 3·23 per cent. and 5·9 per cent. dried at 212° Faht. And in old char, or the stock charcoal of sugar houses, the organic matter fluctuates between 0·2 and 1 per cent., according as the char has been carefully or imperfectly re-burned.

I always dry from four to five hours in the water-bath, and not at 350° Faht., because at the latter temperature a portion of the organic matter is driven off, and a high result obtained.

There is just one other remark about the estimation of moisture in char which I would like to make at present, because I believe from not knowing it many have been led to too low a result. When a sample of charcoal contains 5 to 10 per cent., and the water be determined in a portion of the ground as well as in the unground charcoal, it will be found that the result obtained in the latter case exceeds that in the former by 1 or 2 per cent., and proportionately less when the original sample contains 1 per cent. and less of water. This shows that the char loses moisture during the operation of grinding. Consequently in making a full analysis it is necessary to make two water estimations, one in the ground and another in the unground portion. The former is that used for making up the results of the analysis and calculating to dry charcoal, while the latter is that reported as actually existing in the sample.

## THE RÉGIME ON SUGARS.

In a previous number, we published the project of law on sugars by the Government; we now give that of the Commission of the National Assembly, of which M. Villain is the reporter, and upon which a discussion took place last week.

Article 1. As soon as the present law is promulgated, the refineries, as well as the manufactories, are subjected to the permanent inspection of the Excise officers for indirect taxation; the object of the inspection is, to survey, and to follow all the operations of the manufacture, to ascertain and to assess the quantities produced.

Art. 2. The raw sugars leaving the premises of the manufacturer, or the bonded warehouse, are conveyed under a permit. This permit, in accordance with the rules of the Convention of the 8th November 1861, is delivered at the moment of leaving, and states to what class the sugars belong. The same rule is applied to the raw sugars imported into France from foreign countries, or from the French colonies.

Art. 3. At the time of their arrival in the refinery, the raw sugars are inspected by the Excise officer, and sampled according to classification, in conformity with Article 2.

The regulation of the duties is established upon the real quantity produced and ascertained in refining.

Art. 4. Raw or refined sugars, destined for exportation, not being liable to duty, do not obtain any drawback. They are conveyed to the frontier under the stamped seal of direct taxation, accompanied by a permit, delivered by the Excise. Their leaving the country is verified at the frontier, after examination made by the Excise officers, who take notice of the quantities and keep possession of the receipts or permits, which serve as a discharge, and which are to be returned to the manufacturer or to the refiner.

Art. 5. The duty on sugars intended for consumption is due at the time they leave the manufactory, or the bonded warehouse, or the refinery. The duty is to be paid either by one month's bill, or by cash payment without discount.

Art. 6. The duties on sugars are established as follows:—

1. Sugars of whatever quality leaving the refineries, 70 francs per 100 kilogrammes.
2. Any sort of raw sugars, exotic or indigenous, intended for consumption without being refined, 67 francs per 100 kilogrammes.

Art. 7. Molasses imported from French colonies, or being the result of beetroot manufactories or refineries, and intended for consumption, shall pay 14 francs per 100 killogrammes.

That nothing is to be considered as molasses but the liquid residues obtained from the manufacture of sugar, and containing at most 50 per cent. of sugar, and having at least, at the temperature of 15° Centigrade, a density of 1·349 (38° Baumé) when they are of colonial derivation, and of 1·441 (45° Baumé) when they are the result obtained from beetroot sugar.

An order of public administration, issued in the usual form, shall rule and determine, under sanction of penalties as stated in Article 26 of the law of 31st May 1846, the details and conditions of assessment. It has to be submitted, in the course of three months, to the National Assembly for approbation.—*Journal des Fabricants de Sucre.*

## NOTES ON CONCRETE.

### From Bordeaux.

In reply to our enquiries on the subject in which your friend in Guadeloupe is interested, we have ascertained that five hundred casks of concrete have been imported into Bordeaux in lots of 250. Both lots varied considerably in quality from the lowest and most faulty. They were consigned to a house in the grain and seed trade, thus not in the best position for disposing of sugar, consequently after being some time on hand, the first 250 casks were sold at 50 centimes to 1 franc below the market price; but what showed their value, the second 250 casks were taken by the same refiner who bought the first lot.

If these sugars (concrete) were placed in the hands of a regular sugar broker for sale on the market, and were divided into marks according to quality, so that the purchaser could see exactly what he was buying, they would command sales at as good prices as sugars of the ordinary class.

### From London.

On enquiry respecting sugar made by the Concretor, we find that it sells here readily at good prices, unless soft and pulpy. It should be hard and with good grain. The process is now extensively used, though it has not been in operation long. We do not think that any one but a sugar grower can say whether the Concretor is to be preferred to the old-fashioned apparatus.

### From Marseilles.

Concrete sugars are but little known here; the only parcels imported are from Cuba, and it is not certain whether they were made by Fryers' Concretor. These sugars, crystallized, though very moist, gave good returns on analysis, but, solely because of their moisture, fetched 3 per cent. less than market price. The value of concrete sugars must be estimated by comparison with sugars obtained by crystallization, *i.e.*, taking the actual price of good fourths from the French Antilles as a base, say 36·50 francs;—concrete sugars might fetch 1 franc more, say 37·50 francs. We think that if this process of manufacture were slightly improved, it might produce dry sugars of as good value as crystallized Havana.

# Correspondence.

## ON THE FORMATION OF THE MOLASSES.

To the Editor of the "Sugar Cane."

Sir,

The origin of the molasses continues to be a moot point, whilst the avoidance of molasses is, perhaps, more desirable even than the consequent increase of sugar-product by that avoidance. I beg to submit an attempt at explanation of its origin, which I had occasion recently to send to a planter in the West Indies. I offer it now under the impression that its publication may come under the notice of others who are interested in this important subject, and possibly assist them in coming to a satisfactory conclusion.

I apprehend we may entertain this question, from the beginning, in the interest of the practical planter, and in the absence of the technical accomplishments of the scientific chemist. Common things too, can sufficiently illustrate our subject.

The juice of the cane, which contains the sugar, is, of course, located in its pith, or sap-vessels. These may be compared to a bundle of fragile pipes. These pipes, or tubes, themselves are very thin, and their substance is known as "cellulose." They are bound together by an outer skin or ring, hardened by silex, as are the straws of our wheat plant, and they are cemented together by a gummy matter, which becomes the proximate mover of mischief. It is this gummy matter which passes into a state of fermentation by simple contact with the air.

When the cane is passed through the mill, the pressure then bursts these pipes, and the juice is set at liberty. The refuse "megasse" is led one way, and the juice another. The mill does more, when, in bursting these fragile tubes, it breaks them also into most minute fragments, which is invariably the case. This comminuted *debris* of the cane, is known as "cush," in the West Indies. We find these light, thin fragments of cellulose, *together with their gummy coatings*, distributed plentifully throughout the juice, to play a two-fold mischievous part, to the loss and annoyance of all concerned. Before these diffused atoms of cellulose can fall down, when the juice is left quiescent, we have fermentation and acidity distributed at the expense of contained sugar. This is the apology for hurrying on the juice to the clarifiers, or the pans, to avoid the loss of sugar. It is this gummy matter, so distributed, which furnishes the source of muscus fermentation, which quickly passes on into the vinous and acetous stages of fermentation, to be perpetuated with increasing avidity by albumen, and the albumenoids—also present in the juice—and fed by contained sugar so long as sugar is available, until vinegar be the ultimate result.

Much of this is already well known, and indeed it is supposed to be guarded against, to the extent of adding lime to saturate the acid, and boiling the juice to coagulate the albumen and its congeners; although we have the fact established long since, and often determined and confirmed, that starch, sugar, and alcohol, when acted on by an alkali, stimulated by heat, become vegetable acids. We need not allow pectose and others to lure us here into elaboration for confirmation.

To return to the "cush." If the planter were to mix flour and water, and then boil the mixture, he would, most likely, get a pasty result. Again, if he takes a similar quantity of coarse Scotch oatmeal, which approaches more nearly to the resemblance of "cush," mixes it also with water, and boils this mixture as he boiled the former, he may get a similar pasty result. If he prolong this boiling at an increased temperature, say 230° Faht., about which temperature, or above, we bring the sugar with the "cush" in the open "teche," the coarser portions of the oatmeal, as of the "cush," become softened. Coffee affords a somewhat similar result, with its coloring power added, when carbonised; it is so with "cush." In the vacuum pan as in the open pan, we secure the slimy result, *by boiling the "cush" with the sucrate of lime.* We call this miserable result *molasses.* Because we do *not* raise the temperature in the vacum-pan so high as in the open pan, we do not there carbonise the "cush"; we do not disseminate the newly-formed molasses, do not agitate by boiling together with sugar so long, nor so violently to varnish over and contaminate each sugar crystal, that we do not get such a deep dyed tint as with the open pan.

We come now to a very important point in the process of manufacture of sugar. We add lime to the juice, although a pretty, crystalline, pale sugar can be obtained without lime, yet lime is commonly added, ostensibly to correct any acidity therein, affording that acid the opportunity to combine with that alkali. But we do more, generally, when we add more lime than enough for this purpose, and leave it in the juice to *combine with the sugar*, to form *the sucrate or saccharate of lime*. Now, *this sucrate has great solvent power over gelatinous organic matters, animal or vegetable.* This power increases with an increase of temperature, as then the "cush" becomes more gelatinous, and the product is of a well-known gummy, gluey, slimy character, loaded more or less with sugar. We find a confirmation in daily practice, and in the well-known aphorism "the more lime, the worse sugar." Some sugar-boilers —planters—think they cannot apply lime too soon, others, who produce a superior article, do not add lime *until* such of the "cush" as floats on the surface, has been vigilantly scummed off, they do not "brush" it off, and the froth in their pans has become clean.

The cush when boiled is softened, as already hinted, and like the oatmeal when boiled, becomes, more or less, of a jelly-like mass. It is *now* that *the sucrate of lime* formed in the pan, has the power, and at a temperature as low as 145° Faht., it can act on, to dissolve the "cush," to produce the slimy molasses, and that with increasing avidity, with increase of temperature. It will now be seen that the common temperature to which vacuum-pan sugar is raised, is sufficient for engendering, yet not enough for distributing the amount of mischief which results with molasses on the common process. If however we must show the converse of all this, and it be assumed to be desirable to disseminate impurity through the mass of sugar as it boils, and varnish over each grain with molasses, we have only to add sufficient lime, prolong the boiling, increase the temperature to same degree as we find the sugar when finishing in the open "teche." At that temperature we are also afforded the opportunity of carbonising the sluggish molasses, and unattached "cush" as either comes into contact with the superheated pan, in which it may be so boiled. We get a stronger solution of coffee on a similar principle. Thus may be gotten a mixture of molasses and sugar, as black and slimy as may be desired; always, of course, in the presence of sufficient lime and "cush."

It must be gratifying to know that this may be avoided, without adding anything, good, bad, or indifferent, to offend the scrupulously exact. To this end we have successfully established the foundation, confirmed by experience. Fermentation is arrested in the juice, coagulating the gummy and albumenoid matters by galvanism and separating them and the "cush" by simply filtering it through sand on its way from the mill to the pans. It is almost self-acting, keeping back the "cush" *before it can be softened by boiling, or dissolved in the sucrate of lime*, if lime be added. We thus secure, by my patent process, a superior quality of juice and of sugar-product, in the absence of the more expensive vacuum-pan. We can get a grocer's sugar direct, and a better price from the refiner than he affords for common process sugar, owing to the greater economy in passing such a sugar through his bone-filters, being so much freer from impurity; and the advantages of the "Concretor" too, can now be considerably increased. I am accumulating facts transmitted from the West Indies, where my plans are in progress, and will forward the results with much pleasure. Yours obediently,

W. EATHORNE GILL.

34, *South Hill Park, Hampstead Heath, N.W.*

## ON THE UNCERTAIN OUT-TURN OF QUALITY OF FLOATING CARGOES OF SUGAR.

PLYMOUTH.

TO THE EDITOR OF "THE SUGAR CANE."

SIR,

The above subject is attracting much interest just now, and some importers express annoyance that buyers of floating cargoes of sugar are seeking, by joint action, to place upon a more just and honest footing the system which has hitherto been considered the "custom of the trade" in the purchase of sugar afloat. There is however no dictation in the matter on the part of the buyers, as explained in Mr. Gadesden's published letter of recent date.

I will give an instance from an unpublished pamphlet I had written some months since, to show the necessity for an improvement in the system of purchase.

In the season of 1871, the firm with which I am connected purchased a cargo of Bahia sugar afloat; the parties interested in the transaction were of the highest respectability and standing; the vessel was then off the coast waiting orders, and samples were shown in the usual way; on landing the sugar at this port, the sugar was found to be very inferior to the samples shown, to the extent of fully 3s. per cwt., and complaint was immediately made to the selling brokers; the samples were also submitted for examination to one of the most practical sugar analysts of the country. The report of the analysis was as follows:

| | No. 1<br>Sale sample. | | No. 2<br>Sugar received. |
|---|---|---|---|
| Cane sugar .................... | 89·80 | .. | 82·30 |
| Fruit sugar—uncrystallizable .... | 3·34 | .. | 7·45 |
| Extractive and colouring matter .. | 1·88 | .. | 2·81 |
| Ash—soluble .................. | 1·16 | .. | 2·20 |
| Insoluble matter ................ | ·07 | .. | ·10 |
| Water ........................ | 3·75 | .. | 5·14 |
| | 100· | | 100· |
| Colour by Dutch standard ........ | 10 | .. | 7 |
| Cane sugar obtainable ............ | 80·66 | .. | 63·85 |

"REMARKS.—No. 1 is a very fair Bahia sugar, indeed better than many lots I have examined; but No. 2 is very inferior to it in every respect. The relative values are very nearly in proportion to the 'cane sugar obtainable,' which is calculated upon the French system, or very nearly in the proportion of 81 to 64."

Thus it is shown that the value delivered to me is only 64 parts out of the 81 understood to be sold to me when the bargain was made, yet I am bound by the "custom of the trade" to pay every farthing of the money agreed upon at the time of contract.

This instance is one of many well known to all the landing ports, and will, I trust, demonstrate the absolute necessity for some more equitable system in the future.

I remain, sir,
Your obedient servant,
G. H. BROWN,
*British and Irish Sugar Refining Company, Limited.*

## To the Editor of the "Sugar Cane."

April, 1873.

Sir,

In your last number, Dr. W. B. Gerland, in his very interesting remarks regarding the use of calcium, sulphite and bisulphite in the manufacture of sugar, states that the commercial articles seldom contain more than three per cent. of sulphuric trioxide; no doubt he is quite correct in this, in fact, so large a proportion of sulphuric trioxide would be considered very impure by other makers of those articles in this country.

I am, Sir,
Your obedient Servant,
Sugar.

## FRENCH PATENTS.

*(From the Journal des Fabricants de Sucre.)*

96,449. 31 August, 1872. Possoz, 9, Rue du Dome, Paris. *Improvements in the extraction of saccharine juices, and in the manufacture of sugar.*

96,469. 23 September. Lecointe, St. Quentin (Aisne). *Improvements in machinery for extracting and drying saccharine juices from plants containing the same.*

96,472. 23 September. Mariolle, Freres, St. Quentin (Aisne). For an improved pulping apparatus.

96,481. 3 September. Sarrebourse-d'Audeville & Co., 86, Route de Flandre, Pantin (Seine). *Improvements in the manufacture and in the treatment of refined sugar.*

96,491. 9 September. Champonnois, 45, Rue Saint Sebastian, Paris. *For purifying granulated masses of sugar in the process of refining.*

96,557. 13 September. Basset, 60, Rue des Dames, Paris. *New method in the agriculture of beetroots.*

96,602. 18 September. Marguerite, 13, Boulevard Saint Martin, Paris. *For the treatment of crystallizable syrups.*

96,597. 6 September. Muntzig, 45, Rue St. Sebastian, Paris. *Improvements for producing white sugar.*

96,642. 18 September. Partz, 61, Rue du Faubourg, St. Martin, Paris. *Improvements in the manufacture of loaf sugar and in apparatus required for that purpose.*

96,695. 28 September. Dubrunfaut, Ruelle des Meuniers (Bercy), Paris. *Process and apparatus intended to facilitate the practical application of osmose.*

# COLONIAL EXPORTS.

*(From Licht's Monthly Circular.)*

## HAVANA AND MATANZAS.

| FROM 1ST JAN. TO 4TH MAR. | 1873. | 1872. | 1871. |
|---|---|---|---|
| | Tons. | Tons. | Tons. |
| To Great Britain | 449 | 3,923 | 7,735 |
| ,, United States | 32,396 | 35,277 | 28,405 |
| ,, Spain | 5,947 | 4,421 | 5,465 |
| ,, France | 395 | — | 2,221 |
| ,, Northern Europe | 373 | 1,644 | 854 |
| ,, Southern Europe | — | — | 25 |
| ,, Other Ports | 404 | 832 | 751 |
| Total | 39,964 | 46,097 | 45,436 |
| STOCKS | 46,988 | 40,442 | 39,150 |

## MAURITIUS.

| FROM 1ST AUG. TO MARCH 4. | 1872-73. | 1871-72. | 1870-71. |
|---|---|---|---|
| | Tons. | Tons. | Tons. |
| To England | 38,385 | 32,891 | 13,287 |
| ,, France | 16,458 | 13,538 | 5,177 |
| ,, Australia | 30,879 | 19,975 | 27,493 |
| ,, New Zealand | 4,810 | 2,833 | 2,793 |
| ,, Cape of Good Hope | 798 | 860 | 1,809 |
| ,, Bombay | 10,915 | 22,600 | 14,408 |
| ,, Other Ports | 4,078 | 3,503 | 558 |
| Total | 99,251 | 89,761 | 59,727 |

### Stocks of Sugar in the Chief Markets of the World on the 1st March, for Three Years, in thousands of tons, to the nearest thousand.

| | 1873. | 1872. | 1871. |
|---|---|---|---|
| Great Britain | 126 | 111 | 103 |
| France | 151 | 75 | 119 |
| Holland | 48 | 44 | 18 |
| Germany (Zollverein) | 44 | 29 | 44 |
| Six other *entrepôts* | 7 | 5 | 4 |
| Total in Europe | 376 | 264 | 288 |

### Consumption of Sugar in Europe and the United States, for Three Years ending 1st March, in thousands of tons.

| | 1873. | 1872. | 1871. |
|---|---|---|---|
| Great Britain | 731 | 676 | 684 |
| France | 215 | 313 | 315 |
| Germany (Zollverein) | 255 | 215 | 209 |
| Holland | 28 | 22 | 28 |
| Six other *Entrepôts* | 103 | 115 | 87 |
| Total in Europe | 1,332 | 1,341 | 1,323 |

### Estimated Crop of Beet Root Sugar on the Continent of Europe, for the ensuing Season, compared with that of the three previous Seasons.

*(From Licht's Monthly Circular.)*

| | 1872-73.<br>Tons. | 1871-72.<br>Tons. | 1870-71.<br>Tons. | 1869-70.<br>Tons. |
|---|---|---|---|---|
| France | 395,000 | 335,000 | 289,000 | 289,000 |
| Germany (Zollverein) | 260,000 | 189,000 | 263,000 | 217,000 |
| Austro-Hungary | 205,000 | 162,000 | 182,000 | 151,000 |
| Russia and Poland | 150,000 | 90,000 | 135,000 | 133,000 |
| Belgium | 80,000 | 72,000 | 56,000 | 44,000 |
| Holland and other Countries | 35,000 | 25,000 | 17,000 | 12,000 |
| Total | 1,125,000 | 873,000 | 942,000 | 846,000 |

## SUGAR STATISTICS—GREAT BRITAIN.

To 19th April, 1873 and 1872. In Thousands of Tons, to the Nearest Thousand.

| | STOCKS. | | | | | | IMPORTS. | | | | | | DELIVERIES. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. |
| British West India | 12 | 2 | 1 | 7 | 22 | 14 | 13 | 3 | 2 | 6 | 24 | 27 | 19 | 3 | 3 | 16 | 39 | 36 |
| British East India | 14 | 3 | .. | .. | 16 | 4 | 12 | 3 | .. | .. | 15 | 5 | 8 | 3 | .. | .. | 11 | 8 |
| Mauritius ...... | 5 | 2 | 2 | 4 | 11 | 6 | 8 | 1 | 7 | 8 | 24 | 22 | 7 | 1 | 6 | 5 | 19 | 23 |
| Cuba .......... | 1 | .. | .. | 6 | 8 | 8 | .. | .. | 2 | 2 | 4 | 9 | 2 | .. | 2 | 8 | 13 | 10 |
| Porto Rico, &c. .. | .. | 6 | .. | .. | 7 | 3 | .. | 7 | .. | .. | 8 | 3 | 2 | 4 | .. | 1 | 6 | 4 |
| Manilla & Java .. | 22 | 7 | .. | 3 | 33 | 24 | 8 | 5 | 5 | 4 | 22 | 26 | 8 | 3 | 5 | 3 | 20 | 24 |
| Brazil .......... | 2 | 19 | 1 | 3 | 24 | 17 | 2 | 23 | 2 | 4 | 31 | 27 | 2 | 17 | 2 | 7 | 28 | 24 |
| Beetroot, &c. .... | 5 | 2 | .. | 3 | 11 | 11 | 11 | 7 | 5 | 16 | 39 | 43 | 12 | 7 | 6 | 24 | 50 | 49 |
| Total, 1873 .. | 61 | 41 | 4 | 26 | 132 | 87 | 54 | 49 | 23 | 40 | 167 | 162 | 60 | 38 | 24 | 64 | 186 | 178 |
| Total, 1872 .. | 32 | 25 | 6 | 24 | 45 increase | | 43 | 40 | 23 | 56 | 5 increase | | 52 | 40 | 23 | 63 | 8 increase | |

## STATE AND PROSPECTS OF THE SUGAR MARKET.

The state of the market during the past month has presented features altogether of an abnormal character. During the first week the dulness noticed during the greater part of March still continued—a dulness however in no measure caused by any anticipation of disturbance from the Legislature, but dependent upon the heavy arrivals of raw and other internal causes, and not accompanied by sensible abatement in price. When, therefore, the proposed reduction in the duties was declared, the announcement took the trade by surprise, and the immediate result was to throw into confusion every branch of the British sugar industry. Nearly all the refiners, after working up their duty-paid stocks of raw, have stopped work; grocers are anxious to dispose of all the sugar they have on hand, and have ceased buying, and the general result has been almost absolute stagnation. During the last few days, however, as the time for the change approaches, there has been a brisker enquiry for raw sugar in bond, and sales are effected at prices in some case 1s. higher than those obtainable at the beginning of the month. This demand is doubtless owing to a belief that the 8th of May will find both refiners and grocers out of stock—a surmise very likely to prove correct, since it is improbable that the public will consume any less sugar in anticipation of a reduction of a farthing per pound.

The latest quotations of standard qualities of raw are: No. 12 Havana afloat, 26s. to 26s. 6d. Fair to good refining Cuba muscovadoes, 23s. 6d. to 24s. Middling to good brown Bahia, 19s. 6d. to 20s. 6d.; showing a decline of about sixpence for the month upon the two better qualities, the lower remaining unchanged.

The statistical position must be regarded as favourable to a brisk and healthy trade when the new duties come into force: the stock of raw sugar has not risen so high as appeared likely from the general stoppage of refineries; the importations have been of about an average amount, whilst the deliveries show an increase for the year of 8,000 tons over the same period in 1872. Doubtless for the remaining portion of 1873 the difference will be still greater since the consumption cannot fail to be augmented by reduced prices.

The course of the refined market, as was to be expected, has been downward; between the refiner and the wholesale grocer the transactions have been very limited, all available stock of refined sugar being anxiously realized by the dealers, and the buying being of a strictly hand to mouth character. The price of common refined lump is quoted at 38s. to 38s. 6d., against 38s. 6d. to 39s., last month and 42s. to 42s. 6d. this time last year.

# THE
# SUGAR CANE.

No. 47. JUNE 2, 1873. Vol. V.

☞ The writers alone are responsible for their statements.

*For Table of Contents, see opposite the last page of each Number.*

## THE SACCHARIMETER.

### (Its Formation and Use.)

When a crystal of tourmaline is cut in two parts, or slices, and allowed to remain in the natural position, the crystal appears perfectly clear. If, however, the upper crystal be made to move on the lower, being turned so as to be at right angles, a dimness is noticed at the axis of the crystals, which increases in proportion to the angles at which they are turned, until it reaches its greatest opaqueness when the crystals are at right angles to each other.

This may be shown more forcibly by the following figures.

Fig. 1.

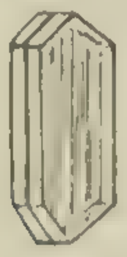


Fig. 2.

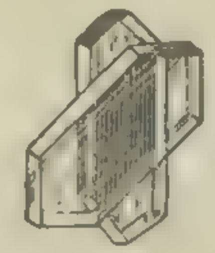
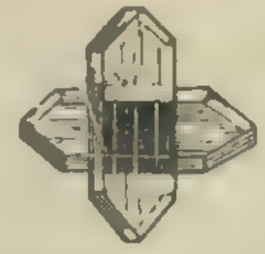


Fig. 3.



In No. 1, we see the tourmaline as it has been cut, and may also observe the position the two slices occupy to each other. In turning the upper crystal towards the right, a dimness is noticed at the axis, as in No. 2; and this dimness has become opaqueness in No. 3, in which the crystals are at right angles. The light which has passed through such a plate is said to be *plane-polarized*. This fact was discovered in 1811, by Arago.

Polarized light cannot be distinguished from ordinary light by the naked eye; to show it, two pieces of apparatus are necessary —a *polarizer* and an *analyzer*. The plate next the eye in the figures just shown is the *analyzer*, the under plate the *polarizer*.

If, now, we separate the two slices and interpose a crystal of quartz, we find that the opaqueness is no longer so determined as formerly, that colour is produced, and, by rotating the analyzer, the colour changes tint.

In 1815, Biot, in experimenting with the essence of terebenthine, discovered the somewhat remarkable fact that quartz was not the only substance which had this power of rotating the plane of polarization, but that it was shared by certain liquids. The essence of terebenthine was the first liquid operated upon. This essence, Biot made to take the place of the quartz. He placed his apparatus so that the light, after passing through the polarizer, should traverse a column of the essence of terebenthine, and he found that as he turned the analyzer to the right the colour changed, exactly as was the case when the quartz was in position, —so that the conclusion thus come to was, that the essence of terebenthine acted in a manner exactly similar to quartz, or in other words, had the power of rotating the plane of polarization.

Once get a start, and it is often easy to proceed rapidly. Biot was not long in discovering other liquids that had the same property, and he also noticed that among these liquids some turned the plane of polarization to the *right*, others to the *left*. The former are called for convenience *positive*, the latter *negative*.

After having got this length, it became necessary to put this discovery as far as possible on a numerical basis, and to define the rotatory power by a number. In order to accomplish this, it was necessary to observe the direction and amount of rotation which the plane of polarization received when a beam of light passed through a column of liquid, whose length was *unity*. After many experiments, Biot determined that the length of the column which he would take as unity (and which has hitherto been taken as unity), would be 1 decimetre, or nearly 4 inches; and as a means of defining the colour of the rays with which he was working, he used a glass coloured red by copper oxide.*

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* The rotatory power of a body is generally represented by $\rho$, and when we say that for a solution of sugar we have—

$$\rho = + 33{\cdot}64^\circ$$

it means that a column of sugar solution 1 decimetre long, deviates the plane of polarization of the red rays towards the right, at an angle of 33·64°

The rotatory power is very variable in liquids, and as it is always feebler than in quartz, it is necessary to use a column several centimetres long. 1 centimetre = 0·39371 inches.*

The importance of this peculiar property which some liquids possess of rotating the plane of polarization, is of the greatest use and value in chemistry. As we have already seen, and which

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* For those who care to enquire more closely into this subject, the following observations will not be out of place.

What we have seen above relates merely to a *single* liquid, but it becomes necessary to enquire whether or no some law could be discovered which would hold good when we had a mixture. Biot then turned his attention to this, with the following results :—

He divided liquids into active and inactive, according as they had the power of turning the plane of polarization or not; if, then, there was a mixture of an active and inactive liquid, the mixture was *active*, provided the two constituents had no chemical action upon each other.

Let $a$ represent the deviation produced by a column of an active liquid, unity in length.
$\delta$ the density of liquid.
$p$ and $p'$ the weights of liquids mixed.
$D$ the density of the mixture.
$L$ the length of column of mixture traversed by the light.

we have for $x$ = the deviation produced.

$$x = \frac{L D a p}{\delta\,(p + p')}.$$

If, again, two active liquids are mixed exercising no chemical action on each other, the rotatory action of the mixture will be equal to the algebraical sum of the actions exercised by each of the liquids mixed, taking into account, of course, the diminution of density caused in each of the liquids by the mixing.

Thus, let $a$ and $a'$ equal the deviations produced by a column unity in length of the two liquids.
$\delta$ and $\delta'$ the densities of the liquids.
$p$ and $p'$ the weights of these liquids.
$D$ the density of the mixture.
$L$ the length of the column of mixture traversed by the light.

then we have—

$$x = \frac{L D}{p + p'}\left(\frac{a}{\delta}p \pm \frac{a'}{\delta'}p'\right).$$

will be more clearly understood by those who read the note on page 283, we have for a basis in the case of sugar (see page 282), the fact that a solution of sugar containing 50 per cent. of cane sugar has a numerical value of

$$\rho = + 33{\cdot}64^\circ$$

Should the plane of polarization be turned to a greater angle, say 38°, we would naturally conclude that a greater amount of sugar was present in the solution. It is by this method that we can follow many of the changes occurring in grain, in sugars, &c., when exposed to the action of acids or other substances, whose influence upon them we wish to determine.

The instrument employed by Biot to measure the rotatory power of liquids is used almost exclusively in France; it is very exact, but requires too many precautions, &c. in regard to the light which must be used.* It should never be used except by cloud-light, and a day should be chosen in which the sky is entirely covered, so that all light polarized by the atmosphere may be avoided.

The apparatus employed by Biot was of the following description:—

The light is polarized by a black plate, nearly horizontal, which can be moved by means of a screw, in such a manner as to give the inclination necessary for complete polarization. This plate is outside a dark chamber, the side of which is pierced with an opening, which allows the reflected light to pass. This light passes through a long tube, then falls upon the analyzer; the analyzer is then moved in such a manner as to obtain the extinction of one of the two images. The tube contains the liquid upon which it is wished to experiment; it is closed at its two extremities by two glass plates, and generally contains inside two silver diaphragms, each pierced with a central hole for the purpose of arresting any light that might accidentally penetrate into the tube.

For the purpose of adjusting the instrument, this tube is replaced by another empty tube of the same length, of which the interior walls are blackened, the analyzer is then turned so as to produce the extinction of one of the two images, if homogeneous light is used, or a decided tint if white light is employed; the empty tube is then removed and replaced by the tube filled with the liquid upon which the experiment is to be made. The angle to which it is necessary to turn the analyzer in order to obtain either the extinction of one of the images or the decided tint, as before settled on, indicates the amount of rotation produced by the column of liquid contained in the tube.*

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* *Comptes Rendus*, xi. 413.

Biot, for no particular reason, always used as an analyzer, instead of a Nichol's prism,† a double refracting achromatic prism.

H. A. Smith.

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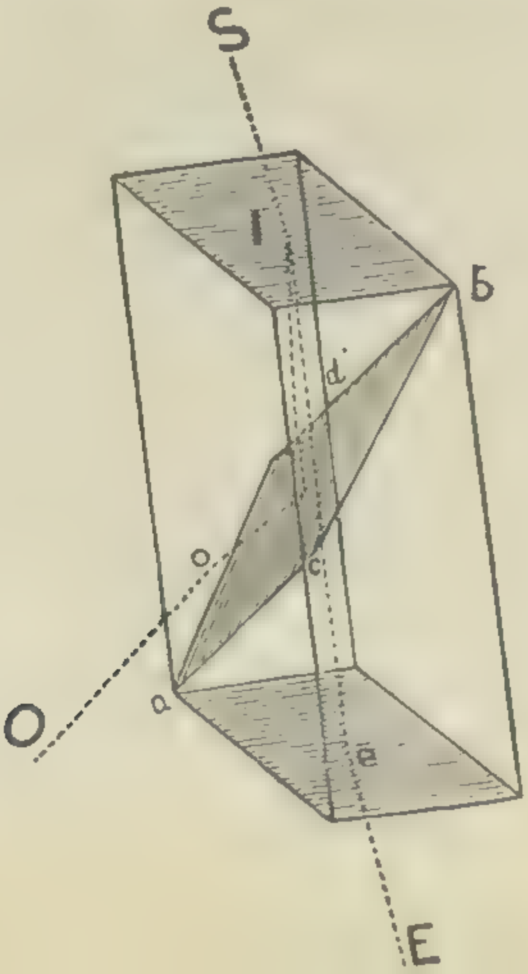
* Verdet's *Optique Physique*. Paris, 1872. Vol. vi.

† Instead of using two tourmaline plates for the purpose of polarization, a more effective instrument is that mentioned above as the "Nichol's prism." It is made by splitting a rhomb of Iceland spar along a diagonal plane, a, b, c, d (Fig. 4), and cementing the two pieces together again by means of Canada balsam. This cement has a refractive index midway between the ordinary and extraordinary indices of the crystal. Suppose, now (Fig. 4), S I be a ray of light entering the crystal at I; it traverses the crystal till it comes in contact with the surface of the Canada balsam, here the ordinary ray is totally reflected, and passes out of the crystal at O o; the extraordinary ray, on the other hand, passes through the crystal and balsam, and emerges from the crystal at S E, in a direction parallel to that in which it entered at S I.

Fig. 4.



## ON IRRIGATION.

The presence of moisture is one of the most conspicuous and peremptory conditions of life, for both plants and animals. When the moisture is diminished below a certain amount, death ensues, and so long as sufficient moisture is withheld no life will appear.

Water is required by the plant, both as a source of nourishment and as a vehicle for the distribution of food for assimilation. It is an essential in the internal economy of the plant, where all the traffic is carried on by water transport.

Plants vary very much in the amount of water they require for healthy subsistence, thus we find succulent plants taking up their position where they can be kept moist, as by the sides of streams, and in marshes, whilst on the bare dry sand, certain grasses and such plants as the sand thistle can sustain life. For this reason drought is much more fatal to some plants than to others. For the grain crops, for instance, if the season be a little drier than usual, a diminution in the amount of straw is found to be the chief defect, but in such succulent plants as the beet root, on the other hand, the consequences are much more serious. An extra dry season may ruin the crop of beets, for the sugar manufacture, by reducing them to one-fourth, or even less than that, of their ordinary value, and this from the fact, that the sugar is only to be found in the juice. When we consider that nearly three-fifths of the sugar itself consists of the elements of water, and that this has to be kept dissolved in a large quantity of the same fluid, we can readily understand the press there is for liquid. The same applies, in a greater or less degree, to all vegetable produce. One has but to pass in review the different countries of the world, to see to what extent sterility attends on drought, and how fertility goes hand in hand with the supply of moisture. There is an interdependence, moreover, between vegetation and the hygroscopic condition of a region, whilst a want of rain prevents vegetation springing up, if we force up vegetation we produce a moister climate. On the other hand if vegetation be removed, as by felling the forests, a diminution in the rainfall ensues.

Whilst it is necessary for all vegetation, and, therefore, for the cultivation of crops and pasture, that there be a sufficiency of moisture, it is, at the same time, of equal importance that the supply be not too great, for if, through too much rain, or from want of adequate openness or porosity in the soil, the water is detained and allowed to stagnate, the ground becomes, in this case also, unfit for agricultural purposes. For the successful cultivation of the land, then, it is necessary that the soil be maintained in a certain medium state of moistness. Excess of moisture produces the marshy and swampy ground, which requires drainage to bring it into a suitable condition, whilst a want of moisture gives rise to the desert and the waste which call for irrigation.

Here there is great scope for enterprise. We need not go out of our own little Island to find many an acre of land awaiting reclamation, many a square mile, indeed, ready to yield a plentiful increase whenever it receives a regulated supply of water. It would be well if more were to take a lesson from the "Northern Farmer," whose last hours were sweetened by the reflection, that he had "stubb'd Thornaby waäste," for it cannot be denied that he thereby conferred a benefit on his country, a benefit which, although it may have been humble, was at least substantial.

If we pass to foreign countries again, we find almost endless tracts of land, which a good supply of water would change from barren wastes into fertile plains; many rich soils too lacking only the supply of water. To accomplish all this, we have to look to a good system of irrigation, at the same time having regard to the forest culture, for the reasons already given.

There is thus a double method of approaching this problem,—the careful preservation and planting of trees, and a regulated artificial distribution of water to the soil by irrigation. By the first method the rainfall is raised, and by the second, the first is supplemented. We have many examples all over the world, of the manner in which the cultivation of vegetation increases the moistness of the climate, and thus assists the endeavours of agriculturists, as in the north of China for instance. There are also woeful examples of a diminished rainfall caused by the reckless felling of forests and the burning of wood and grass.

Too much attention can scarcely be paid to this subject. It would be well if the rule were more generally enforced, as it is so far away as Japan, that for every tree cut down a sapling be left in its place. The Germans have for long furnished another wholesome lesson, by instilling into the youths at the Universities the principles of forest culture.

Trees attract and detain the passing moisture, which is then stored up in the soil, they also tend to equalize the hygroscopic state of the surrounding atmosphere by pumping up the water again from the ground and giving it to the air when it becomes dry.

So important is the supply of a due amount of moisture to the plant, at the proper season, that even in comparatively fertile soils the yield is found to be wonderfully increased by careful irrigation. This is independently of manurial irrigation. Water and manure may be applied at the same time, as when the soil is flooded with sewage, a process of irrigation which is likely to come into much more frequent use, especially in the neighbourhood of large towns.

It has been objected to irrigation, that it is unhealthy, but this is a calumny and is far indeed from the truth. Irrigation when applied intelligently and in accordance with scientific principles, administers to the health of the ground, that indeed is its object; and what produces healthy ground, enabling it to yield the largest amount of healthy produce, surely cannot be convicted of spreading disease. Indeed, grave suspicions were entertained by many on sanitary grounds, with regard to the wisdom of applying the town sewage to land as manure, but even these have been shown in a sufficient number of instances to be entirely unfounded. The crop produced is healthy and profuse, and the animals fed on pasture land treated in this way are healthy. We must not forget that the soil is one of the most powerful natural disinfectants. Of course, if the irrigation be improperly carried out, as by running on too much liquid for the capacity of the soil, so that the ground is kept soaked we may, it is true, produce an artificial marsh or swamp, and thus carefully prepare what, in some countries, may result in a malarious bed. It is probable enough that this state of things is really brought about in certain places, as in the cultivation of rice, for which, in some districts, irrigation is largely employed, but this is the abuse and not the intelligent use of irrigation. Most great powers for good are capable of being converted in unskilful hands into as great powers for evil.

When we reflect that in many countries for want of a good rainy season, famines are liable to ensue, through which thousands perish miserably by the most painful of deaths, then the need of an effective system of irrigation assumes for us a most serious importance. We find savage tribes made to appreciate by a painful experience the value of the rainfall, and so impressed with its importance that they have for long been in the habit of superstitiously appointing men to the charge of regulating it and furnishing a supply during drought. Irrigation however makes us independent of the rainmakers. The science of irrigation has surely a great future before it, with so much to be done, such room for the safe investment of capital in highly profitable philanthropy.

Perhaps no better example can be cited of what skilful irrigation may be made to do, than that garden in the desert which has been raised up, as by enchantment, through the genius and enterprise of Brigham Young. This has all been effected by a supply of water brought from the distant hills, which as usual has had the additional effect of entirely changing the climate of that region in a comparatively few years. Further examples in this direction are being set us elsewhere, which it would be well for all those interested in the cultivation of land to study with attention.

In the north of Italy, at the present moment, the Italian Irrigation Company are still engaged in their most praiseworthy irrigation schemes. Under their direction the waters of the Po are being distributed, by means of canals, over the stretches of country adjoining the right and left banks of the river. Large sandy tracts situated in the Lomellina, and hitherto entirely uncultivated, are now being prepared against the coming of the waters, when they will be largely devoted to the cultivation of rice. A considerable portion of the work of irrigation is already finished and the remainder is being hurried towards completion.

The branch canal now in course of preparation, which is to lead the waters of the Po for distribution over the central portion of the Lomellina, is 9 kilos., or a little over 5½ miles long, and 5 metres, or nearly 16½ feet in width.

On the right bank of the Po there is another tract of country called the Agro Casalere, between Casale and Valenza in Piedmont, to which the same Company is directing its attention. It is proposed to irrigate this district by leading a main canal, in the first place, from a point on the Po, situated about 3 kilos. above Casale. This canal after being led past Casale is to divide into two branches,—the one, a high level canal, to irrigate the higher lands, whilst the other, a low level canal, will be water carrier to the low-lying districts. To afford an idea of the magnitude of this undertaking, the dimensions of the three canals in English feet are here given.

The length of the main canal, extending from the head works to the sluice-house, will be 10,518 feet, or almost exactly 2 miles, with a uniform bottom width of 26¼ feet, and a depth of 6½ feet. The high level canal is, in the meantime, to be 34,584 feet, or nearly 6½ miles long, and setting out with a width of 23 feet, it will gradually narrow to 9⅘ feet, whilst the depth will be 4·9 feet. The low level canal will have a length of 16,414 feet, equal to 3⅒ miles, as it leaves the sluice-house its width will be 16⅖ feet, which will gradually narrow to 13⅒ at the other extremity. This last canal will also have a fall of 11⅘ feet, affording a source of considerable motive power. There will thus be a total canal length of 11⅗ miles. The estimated outlay for the undertaking is given as 586,000 fr., or about £23,440, not including the head works and the first 1640 feet of the main canal.

It may be a matter of surprise to some that such barren ground as stretches of sand can be made to support vegetation simply by the application of water. Those have only to remember that plants derive almost all their nourishment from water and air alone. They have to depend on the earth merely for their mineral ingredients and the mineral ingredients constitute in general only from 1 to 5 per cent. of the entire plant. It is also to be remembered that however the water may fail there is at least never a deficiency of air, which is free to all the world, to the desert of sand as well as to the cultivated plain. Starch and cellulose together constitute the greatest part, perhaps as much as seven-eighths, of the dry matter of vegetation and these are entirely made up of the elements of water and air. So we have only to give the plants to drink and they will convert the air and water into food for us.

We must consider too that all natural waters, which would be used for irrigation purposes, contain varying amounts of inorganic salts in solution ready to assist in the nourishment of the crops, and when the water supply is derived from rivers, there is always in addition a certain proportion of inorganic matter in solution or held in suspension. In many cases indeed the amount of rich alluvial soil carried down by rivers is very considerable and adds in no small degree to its manurial value.

But as we have seen, it is not only in the case of such arid tracts of country as the burning sands of India, or even of the smaller parched wastes to be found in all parts of the world, that irrigation is of value, although these may call loudest for it, but it may be very profitably applied to ground already yielding a fair amount of produce.

If we turn to Lombardy we shall find an alluvial soil, consisting of sand and clay, with a vegetable layer from 7 to 14 feet thick, being placed under irrigation. Now any system that can irrigate profitably a soil that is productive even in its ordinary unirrigated condition, is surely worth our careful consideration.

The tract of country where these operations are being carried on, is situated, for the most part, in the Milanese province, and the water for its irrigation is drawn from the Lake Maggiore. It comprises an area of 216,234 acres, or nearly 338 square miles, and supports a population of 459,166. The project is supported by a small, but enterprising, Company of local shareholders.

Although the land is rather dry, from some reason not sufficiently well understood, still the inhabitants have managed, unaided, to cultivate the ground with considerable success. No complaints appear to have been made, the tenants paying their rent in kind.

A portion of the land is woodland or covered with heather, but it is proposed to place the whole of this under cultivation. Another considerable proportion is devoted, at present, to the cultivation of vines and mulberry trees, but as only a very poor quality of wine is manufactured in the district, it is further proposed to convert most of the vineyards into arable or pasture lands. The cultivated soil has been chiefly laid out in wheat, rye, and maize.

Under the present *régime*, the rotation of crops in use, is on a biennial system. During the first year the land is laid out in wheat or rye say, succeeded by millet or autumnal maize for the second crop, then the second year is made to open with a yield of spring maize. The rotation of crops has always been allowed to be a question of the greatest importance for the agriculturist. Long practical experience has shown the wisdom of giving close attention to this particular, and the progress of agricultural chemistry adds additional weight, if that were required, from theoretical considerations. This district is specially favoured, by having the best technical advice in its midst, namely, the Milan School of Agriculture, which diffuses with a profuse hand the most liberal and enlightened views on the theory and practice of the most economical cultivation of the ground.

In order that the greatest advantage may be taken of the plentiful supply of water about to be distributed, a five years rotation of crop has been carefully drawn up to be adopted by all the tenants.

Since the rotation here to be adopted, as most applicable to the region in question, will be of considerable interest, as an example for others to build upon, we subjoin it in full as contained in the following Table :—

## TABLE FOR QUINQUENNIAL ROTATION OF CROP.

| Number of Parts. | First Year. | | Second Year. | | Third Year. | | Fourth Year. | | Fifth Year. | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1st Crop. | 2nd Crop. | 1st Crop. | 2nd Crop. | 1st Crop. | 2nd Crop. | 1st Crop. | 2nd Crop. | 1st Crop. | 2nd Crop. |
| 2 | Permanent Pasture throughout. | | | | | | | | | |
| 1 | Colza .... | Maize, aut. | Wheat .. | Bulato .... | Maize .. | ........ | Wheat .. | Bulato .... | Fallow .. | ........ |
| 1 | Flax .... | Maize, aut. | Wheat .. | Bulato .... | Fallow .. | ........ | Flax .... | Maize, aut. | Rye .... | Bulato. |
| 1 | Grass.... | ........ | Flax .... | Maize, aut. | Rye .... | Bulato .... | Maize .. | ........ | Wheat .. | Bulato. |
| 1 | Wheat .. | Bulato .... | Fallow .. | ........ | Flax .... | Maize, aut. | Rye .... | Bulato .... | Maize .. | ........ |
| 1 | Rye .... | Bulato .... | Maize .. | ........ | Colza .... | Maize, aut. | Wheat .. | Bulato .... | Maize .. | ........ |
| 1 | Wheat .. | Bulato .... | Maize .. | ........ | Wheat .. | Bulato .... | Maize .. | ........ | Colza .... | Maize, aut. |
| 1 | Maize .. | ........ | Colza .... | Maize, aut. | Wheat .. | Bulato .... | Fallow .. | ........ | Flax .... | Maize, aut. |
| 1 | Maize .. | ........ | Rye .... | Bulato .... | Maize .. | ........ | Colza .... | Maize, aut. | Wheat .. | Bulato. |

N.B.—The Maize, when not mentioned as Autumnal Maize, is Spring Maize.

Note.—*Engineering*, Vol. xv., p. 37.

A farm of 5 acres, according to their plan, would be laid out in the following manner:—one acre of permanent pasture, one acre of spring maize, and another of autumnal maize, an acre and a half of wheat and rye, and half an acre of grass. Of these the two last, when cultivated under the new *régime*, will suffice to clear the rent and the expenses of irrigation, leaving the produce of the remaining three acres for the tenant and his family to live upon. We have next to consider the amount of water supplied, and the method of its application.

(*To be continued.*)

## ANALYSIS OF ANIMAL CHARCOAL.

By Alexander S. Wilson.

In a recent number of the *Chemical News* (vol. xxvii., p. 111, *Sugar Cane* for May, page 266) a startling statement was made by Mr. T. L. Patterson to the effect that animal charcoal or bone-black, prepared by exposing bones to a red heat for many hours, contains a large proportion of organic matter; while he further affirms that the moisture in the charcoal must not be estimated at a higher temperature than 212° Faht., because a greater degree of heat would decompose the organic matter.

On the other hand, it has been affirmed by Dr. Wallace that water in new charcoal is only partially expelled at 212°, and that a much higher temperature is necessary for its complete removal; that, of the nitrogen in the charcoal, a minute proportion only exists as ammonia; and that the matter reported in analyses as carbon (nitrogenous) should be estimated by adding to the insoluble carbonaceous matter the amount of nitrogen with hydrochloric acid.

Having given some attention to this subject, I was induced, by Mr. Patterson's remarks, to make the following experiments, with a view to obtain some more information on the point. A sample of new charcoal (probably of foreign manufacture) was selected, and subjected to the following experiments:—

(1.) A quantity of the sample was ignited, and afterwards treated with ammonium carbonate to insure that no carbonic acid was driven off. The loss was found to be 19·02 per cent.

(2.) The insoluble in HCl was determined, and the mean of several experiments gave 13·20 per cent. This insoluble was ignited, and gave 2·35 as the mean percentage of ash or silica; this, subtracted from the former amount, gives 10·75 per cent. of what is usually reported as carbon.

(3.) The amount of nitrogen in this so-called carbon was estimated, and was found to be 0·39 in 100 parts of charcoal.

(4.) The total quantity of nitrogen in the charcoal was found to be 0·52 per cent.

(5.) The water was estimated directly, in an arrangement by which a current of perfectly dry air was passed over a weighed quantity of the sample, placed in a platinum boat in a tube which was heated during the experiment. This air was then deprived of the moisture it had taken up from the char by being passed through a chloride of calcium tube. Three careful experiments gave, respectively, 7·42, 7·45, and 7·57 per cent. In two of these experiments, a small Bunsen was used to heat the tube containing the boat with the char, and in the third an argand; but in none of them could the heat have been sufficient to convert any hydrogen that might exist in the char, either free or combined, into water; and further, as the amount of hydrogen in charcoal is always very minute, there could not be much chance of error from this cause. The calcium tube was small and of that form in which most of the water is received into a bulb, and does not pass into the solid chloride. The water was in this case removed from the bulb and examined; it was alkaline, and gave, on evaporation, a distinct residue of organic matter, too minute, however, to affect the balance, and consequently to impair the accuracy of the above results.

(6.) Another quantity of the sample was treated in the same manner as that in the above, except that the current of air from the char was passed through dilute HCl. The amount of ammonia absorbed was found to be 0·05 per cent., so that, even were the whole of this amount retained by the calcium chloride, the above results (5) would only be lowered by 0·05 per cent.

| | | | | | | Per cent. |
|---|---|---|---|---|---|---|
| (7.) The loss of weight | at | 212° Faht. | in | 5 | hours was | 4·73 |
| ,, | ,, | 350° | ,, | ¼ | ,, | 6·10 |
| ,, | ,, | 360° | ,, | ,, | ,, | 6·45 |
| ,, | ,, | 500° | ,, | ,, | ,, | 7·53 |

These results appear to show that Mr. Patterson's "organic matter" consists chiefly of water, which is not expelled at 212°.

The method of analysis pursued gives the following results:—

| | |
|---|---|
| Insoluble carbonaceous matter | 10·75 |
| Nitrogen removed by dissolving in acid | 0·13 |
| Carbon (nitrogenous) | 10·88 |
| Water by direct estimation | 7·48 |
| Unaccounted for | 0·66 |
| Loss on ignition | 19·02 |

According to Mr. Patterson's method, we should have—

| | |
|---|---|
| Carbon, including some insoluble organic matter | 10·75 |
| Organic matter dissolved | 3·54 |
| Water at 212° | 4·73 |
| Loss on ignition | 19·02 |

Further estimations of the insoluble, obtained by treating the charcoal with caustic soda to dissolve the so-called insoluble organic matter, show that this organic matter is nearly, if not absolutely, equivalent to the 0·39 of nitrogen found in the insoluble, and that any other insoluble organic matter must be very inconsiderable indeed. This agrees with Mr. Patterson's experience, for he says that only a small portion of the organic matter is insoluble in acid.

Any organic matter, then, other than nitrogen, that may be found in charcoal must consist chiefly, if not entirely, of the constituents of bone-tar, and traces of ammonia which must necessarily be retained from the distillation of the char; hence arises the necessity of washing and re-burning charcoal before employing it in sugar refining. I may add that previous experience gives a larger proportion of nitrogen in new charcoal than was found in the sample selected for the present experiments.—*Chemical News.*

# ON THE ACTION OF ANIMAL CHARCOAL.

## REFUTATION OF M. WERNEKINK'S THEORY.

BY DR. KOHLRAUSCH.

(Continued from page 184.)

Independently of these experiments we operated on another portion of freshly calcined charcoal; this was well dried in the air at 110° C., after the estimation of the ammonia, so as to assist the absorption of nitrogen from the atmosphere, it was then analyzed after being replaced in the apparatus. These experiments, although repeated several times, never showed any appreciable amount of ammonia in the second determination.

What likelihood or probability is there then in M. Wernekink's theory in the face of such results?

This source of ammonia was exhausted after every determination of these analyses, the absence of which served him as a basis for argument; we now beg to lay them before him. There now remains but one last observation to notice, that is, that the amount of ammonia would be "evidently" much too large to attribute it to the combustion of nitrogenous matter, the greater part of which had already been removed before calcination, by fermentation, washing, &c. We consider the expression "evidently" badly chosen, and it would perhaps be better to replace it by this other, "to judge of it by the smell."

If M. Wernekink misunderstands the theory which attributes the ammonia to the combustion of nitrogenous matter, the reason is that he evidently applies it exclusively to those nitrogenous substances which the char has absorbed from the sugar. But never, to my knowledge at least, has such an interpretation been entertained by any competent person, unless to prove that the char has been badly burnt and not properly divested of the organic matters which it has retained. Charcoal when well burnt will always contain a very small quantity of ammonia, depending upon the amount of organic matter absorbed.

M. Wernekink appears to base an argument upon the fact that it is common (and according to his theory it is perfectly legitimate) to judge of the efficiency of the char by the greater or less amount of ammoniacal odour which is given out by treating with steam. We fully concur with M. Wernekink that this is a correct assumption, though we prefer to think that the reason is not based upon his hypothesis, but simply upon the circumstance that a char which is rich in carbon will produce by calcination and consequent combustion of the residual nitrogen more ammonia than a char which contains less carbon, and also that the porosity and general physical qualities of the char correspond to the amount of carbon it contains.

Viewing the question from this stand-point, and not attributing the origin of the nitrogen more to the residue of organic matter left in the char after combustion than to the atmospheric air, there is absolutely nothing contradictory in the conclusion that the stronger the ammoniacal odour the more powerful is the action of the charcoal.

We believe, moreover, that the calcination should be so regulated that the smell of ammonia may not be too strong on treating with steam,—for although the odour is always an indication of the efficiency of the char, that is to say, of its complete deprivation of organic matter, yet it must be borne in mind that in proportion to the disappearance of the carbon necessary to the composition of the char, so does the char lose in decolorizing power, and this so much the more rapidly if the substances absorbed have not been first properly removed, or as the formation of a slimy vegetable carbon takes place, which stops up the pores. It would be infinitely better for the manufacturer to omit calcination or to burn without rendering apparent any trace of ammonia on treatment with steam; for the char would thus preserve its decolorizing power much longer; and it is to be regretted that those processes which follow this principle, such as the Eissfeld-Thumb process, have not yet led to results which are perfectly satisfactory.

By means of his "theory," M. Wernekink thinks that he has discovered the cause and the cure for many a difficulty in practical manufacture. Thus, for example, he proposes to prevent the formation of ammonia by omitting to pass the char through steam before filtration, hoping thus to avoid the formation of the nitrate of ammonia and copper, which occurs by the contact of syrup containing traces of ammonia with the copper surfaces of the vacuum pan; this nitrate, in presence of the organic elements of the syrup, will produce a strong taint of copper salt, rendering the sugar grey. This is a well known fact, but here again M. Wernekink's observation of it rests upon an error.

After having shown that the ammonia is not formed by the action of steam upon the condensed nitrogen, but exists entirely in the nitrogenous matter which adheres to the pores of the char: we can only repeat the old receipt—continue the steam treatment till ammonia can no longer be detected. We may remark at the same time that perhaps it would be economical to collect the ammoniacal water which drains from the steam cylinders, and to use it in the same way as the wash waters for the purification of the char.

Lastly it seems to us, after what has before been said, useless to prove the fallacy of the statement that, by passing a current of steam through calcined animal charcoal ammonia and its salts may be economically obtained. Indeed, the char used by us, for example, contained about 1·3 per cent. of nitrogen, from which might be obtained, after allowing for loss in calcination, about 1·6 per cent. of ammonia, the value of which bears no comparison to the cost of the raw material.—*Journal des Fabricants de Sucre.*

## CALIFORNIA BEET SUGAR.

The Alvarado (Cal.) Beet Sugar Mill has been running about two months and a half on the beet crop of 1872, and will probably be busy four or five months more, working up fifty tons of beets a day. The Alvarado crop, of 1870, yielded 223 tons of sugar; that of 1871, 335 tons; and that of 1872 will be between 446 and 558 tons. The average per centage of sugar obtained from the beets was under eight, in 1870; about eight, last year; and is eight and a quarter now.—*The American Grocer.*

# CONDITIONS

## TO BE PRINTED ON THE BACK OF EACH CONTRACT FOR SUGAR PURCHASED PREVIOUS TO LANDING.

*Agreed to by the British Sugar Refiners.*

1.—The seller guarantees that the sample exhibited at the time of sale of the within sugars is a fair one, and that the bulk shall turn out in the case of dry sugars equal to such sample, and in the case of moist sugars, within sixpence per hundredweight of such sample.

2.—A portion of the sample exhibited at the time of sale shall then and there be sealed up in a glass bottle, and remain in the hands of the selling broker.

3.—The out-turn of the sugars sold shall be determined by samples taken immediately on landing, under the supervision and in strict accordance with the regulations of the Customs authorities, and a fair and equal average thereof shall be made up as next hereinafter provided as soon as possible after the landing is completed.

4.—The average sample of the out-turn shall in all cases be made up at the expense of the buyer, by the sworn sampler if there be such an officer at the port of discharge, but if there be no such officer then by the selling broker or some other agent of the seller; but in case the seller shall omit to get such average sample of the out-turn made up within twenty-four hours after receiving notice from the buyer that the sugars are landed, the buyer shall be at liberty to get the same made up, and the seller shall be bound thereby.

5.—A portion of the average sample of the out-turn shall, as soon as the same shall have been made up, be sealed up in a glass bottle by the person making the same, and remain in the hands of the selling broker.

6.—The buyer shall have sufficient notice of and a right to be present at the sealing up both of the sale sample, as provided by the second Condition, and of the average sample of the out-turn, as provided by the fifth Condition, and also to affix his own seal thereto. He shall also have sufficient notice of and a right to be present at the making up of the average sample of the out-turn, as provided by the third and fourth Conditions.

7.—If the out-turn (determined as provided by the third Condition) shall prove to be inferior to the selling sample, the seller shall allow, in the case of dry sugars, a deduction from the price of the whole amount of inferiority, and in the case of moist sugars, a deduction of the amount of inferiority (if any) in excess of sixpence per hundredweight.

8.—In case of difference between the parties with respect to the amount of inferiority, the sealed up portions of the sale sample, and of the average sample of the out-turn, shall be submitted to two referees, who shall certify the respective market values on the day of reference of the two samples so submitted to them and nothing more, and the difference between such market values shall as between the parties be and be deemed the amount of inferiority.

9.—The reference shall in all cases take place at the port or place of sale unless otherwise provided by the contract, and the appointment of referees and the mode of deciding between them in case of difference shall be regulated according to the custom or public sale conditions (if there be any) of the port or place of sale, but if there be no such custom or public sale conditions, then a referee in the trade is to be nominated by each party, and the two referees are, before entering upon the reference, to appoint in writing an umpire, who is to decide between them in case of difference, and in case either of the parties shall fail to appoint a referee within forty-eight hours after notice from the other to do so, such other party may appoint both referees and the reference may be so proceeded with.

10.—Should the amount of inferiority in the case of dry sugars exceed one shilling per hundredweight, or in the case of moist sugars two shillings and sixpence per hundredweight, the buyer is to have the option either of rejecting the sugars or of accepting them on the terms of the seventh Condition.

We, the undersigned sugar refiners, hereby mutually undertake and agree* not to buy any sugars not landed except upon and subject to the above special conditions, which are to be incorporated in the contract. And we hereby further mutually undertake and agree not to purchase any sugars that are not represented either by Dutch standard, by sample, or by analysis.

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* Subject to such modifications as we may *unanimously* agree upon at the suggestion of the sellers.

## THE "CANE BORER" IN THE MAURITIUS.

(*Continued from page* 160.)

The attention of the public was called to that alarming fact by the Society of Arts and Sciences, which then recommended some precautions, which were unfortunately neglected by those who never dread a danger until it is too late, and until the blow has actually struck them.

It is right to state that, at the very moment when this new enemy was seen on the estate of the Honorable Captain West, it also made its appearance on the estate of one of the members of the Committee, (the Honorable C. Wiché,) and that it was first noticed on canes which had lately been introduced from Java, by the ship *Reliance*. It might have been deduced from the fact, that the Borer was introduced from Java, and not from Ceylon, or simultaneously from the two places. However, it did not appear probable that the existence of such an enemy should not have attracted notice long since, in a country which produces so much sugar as Java, and, above all, that its existence should not have been made known to the Mauritians by the distinguished naturalist, (Mr. Diard, Superintendent of Government Cultivation at Java,) to whom the order for these cane plants had been specially addressed, for the purpose of getting rid of another scourge, and who, in consequence, would not have failed to warn the Island of its exposing itself to a danger of a still more dreadful nature. This reasoning appears fully justified by the fact that, at Flacq where more canes from the *Reliance* had been planted than in any other district, the "Borer" has hardly made its appearance, though more than four years have elapsed since those canes were planted. It appears then likely that, to the canes of the *Elizabeth*, from Ceylon, must be referred the introduction into the colony of this dangerous insect. The fact of its existence being unknown previously appears undoubted, and yet its propagation during the course of seven years has not been very great, not exceeding a radius of more than six miles.

But, at the same time, the Committee must repeat that, in the present state of things, the other districts of the Island can only be preserved by prompt, energetic, and persevering measures, for one has no longer to deal with isolated insects, but with millions of them consequently multiplying in a frightful progression.

It is not with the view only of calculating the progress of this new scourge, that the Committee have thought necessary to find out the date of its introduction, (as much as it has been possible so to do) they have also done it in an historical and scientific point of view, and for the purpose of demonstrating once more how cautiously must be watched and controlled the importations of one country into the other, since the ruin of a whole community may be brought about by one of the most despicable in the Almighty's creation.

After having traced the history of the Cane Borer in Mauritius, the Committee will proceed to describe it as briefly and as exactly as possible, in order that it may be recognised here and elsewhere, and to give a rapid sketch of its manners and habits, to show its ravages, and to indicate the means of destruction that may be resorted to against it.

Let us, in the first instance state, that there are two species very distinct, which may be recognised by the following characteristics: one belongs to the tribe of Moths indigenous to the Colony, the other belongs to the section of *Pyralites*, insects most destructive to all kinds of cultivated vegetables in all parts of the world. This last is the true "Cane Borer" *Proceras sacchariphagus.*

The following is the description and the characteristics of the genus of this insect, given by the President of the Committee, Mr. Bojer:

"The lepidopterous insect which comes from the boring caterpillar belongs to the great family of Nocturnal Butterflies. If we consider the character of the butterfly, of the caterpillar, and particularly if we take due notice of how the latter lives and feeds under cover in the interior of the sugar cane, where it undergoes all its metamorphoses, we shall see that our lepidopter belongs to the 6th section of nocturns or *Tortrices* of Latreille (*Nocturnæ tortrices* of Linneus), and forming the genus *Proceras* of Hübner, in the tribe of *Pyralites* of Lamark, having for its type *Pyralis soldanana* of Fabricius, which is distinguished from the genus *Pyralis* by the inferior palpi which are twice and a-half longer than the head, projecting in the shape of a straight beak—our butterfly corresponds perfectly with the above, so we shall leave it in the tribe of *Pyralites* and in the genus *Proceras* or "Cane Borer" *(Proceras sacchariphagus).* It must also be remarked that the *Proceras* has some affinity with the genus *Crambus* of Fabricius, but the wings of the *Crambus* being narrow and rolled round the body, give it a form almost cylindrical, whilst the *Proceras* has triangular wings, flat, or slightly sloped. Besides, the *Crambus* belongs to the 9th section of Latreille or that of *Tineites.*

Here is the character of the *Proceras*, or Cane Borer:

Family, Nocturnal, Latr. (Nocturna, Lin.)

*Section*, Tortrices, Latr. (Tortrices, Lin.)

*Tribe,* Pyralites.. (Lamark.)

*Genus,* Proceras. (Hübner.)

Character of the Genus.—The Antennæ are filiform, composed of numerous short articles of equal size; those at the base are more distinct.

Four distinct palpi; the superior are small and compressed, the inferior are projecting in front in the shape of a straight beak, covered with obconic scales, dentate at their summit. The trunk or tongue is membranous, rolled up in spiral, concealed between the inferior palpi.

The wings form an elongated triangle and are laid almost horizontally on the body, when the insect is in repose, or slightly sloped (in the male) with an inner salient angle at the inferior extremity. The intermediate and posterior legs are armed with spines.

The caterpillars have sixteen *feet*, they live solitarily in the interior of the sugar cane, where they prepare a temporary shelter with the remains of the plant, which they unite by a few silken threads, and in which they more frequently undergo their metamorphoses without preparing more regular coverings. The Chrysalis is naked.

Character of the Species.—*(Proceras sacchariphagus)* "Cane Borer."

The largest butterfly of the *Proceras* that we have noticed was a female, she was 18 lines across the wings, the others were smaller and had but 13 or 14 lines across. The males are always smaller, and are generally only 9 or 10 lines across the wings.

The *Antennæ* are setaceous, reddish brown, they become very slender and almost filiform towards the upper extremity, and are composed of numerous short and equal articles, difficult to distinguish; it may be perceived, when greatly magnified, and particularly in the male (preserved), that the antennæ are compressed, and that the rings appear disposed so as to form notchings like those of a saw, on the internal margin; when the insect is in repose, the antennæ are always laid on the back, and applied against the wings, which are half as long. When the butterfly is on the point of flying, it raises the antennæ a little, so as to form a right angle with the body. The first articles of the antennæ are distinct and rounded at their bases, attached on the forehead, which is broad and on the internal side of the eyes, which are large and black.

The palpi are distinct, the superior are small, rounded, and compressed, covered with scales; the inferior are nearly three times longer than the head, and projecting in the shape of a straight beak, they are sometimes slightly ensiform in the male, and are composed of three unequal articles, covered also with long and serrated scales as well as the forehead, the corselet, the thorax, and the shoulders.

In the female, the wings represent an elongated triangle, laying horizontally on the body, obliquely truncated at their inferior basis, and forming a salient angle more or less open. The male has wings slightly sloped, one of the internal borders of which is covered over by the other, and under which the abdomen, shorter than the wings, is concealed.

When the butterfly is on the point of coming out of its Chrysalis, it begins by piercing the upper part of its envelope. The wings are folded in various directions, covered with a very fine scaly dust of a ferruginous colour on a silvery grey surface; but this dust is so little adhesive to the wings, that upon the least motion, the insect parts with this ornament. The superior wings have each one or two folds, which begin at the shoulder and extend to the centre, and when there, divide themselves into several radii towards the circumference, each is hollowed in the shape of a gutter, with a black vein in the middle, and terminated by a dot of the same colour, on the inferior border of the wings, the number of these veins and of these dots vary much, according to the sex; these external marks give to our Nocturn some affinity with the *Noctua sparganii*, whose larva lives and feeds also in the internal part of the stem of *Sparganium aquaticum*, but differs from it by other characters. In the female, the inferior wings are shorter and thinner, folded longitudinally, the black veins and dots are less apparent, these last are sometimes missed altogether. The underpart of the butterfly is of a grey, silvery, and uniform colour. The wings are bordered with fringes. The anterior legs have no spines, and when in repose, they are directed forward, and parallel to the palpi, which form a very prominent beak, which, with the large black eyes, give to this butterfly a very peculiar appearance, it may even be said, that it has something sinister in its look. The intermediate legs are a little shorter, they have only one pair of spines at the origin of the tarsi; the posterior are a little longer than the abdomen, they have two pairs of spines, one at the origin of the tarsi, the other a little above. The tarsi are composed of five articles, the first of which is as long as the four following, terminated by small hooks. The legs as well as the abdomen are covered over by depressed scales having a silvery iridescent reflect.

The Butterfly of the *Proceras* is very sedentary. We have observed it in captivity, remaining fixed in the same place for 36 hours, concealed between leaves, without even changing its position, its flight is heavy and almost vertical, but when tormented at night by a vivid light, it shudders, jumps, and turns upon itself very quickly, when set at liberty far from being attracted by the light of a candle, it flies on the contrary to the most obscure corner of the room. This peculiarity has confirmed us in our first impression that its large eyes are totally deprived of the choroid membrane, which renders this nocturn little impressed upon by light, and renders it almost blind. It is worthy of notice that this butterfly has not yet been caught in the cane fields, this circumstance would lead to the belief that it remains stationary, concealed under leaves.

The female when depositing its ova shows an unceasing activity, it hops with great vivacity and every time that the egg comes out of the oviduct, the insect visibly experiences a convulsive shuddering which makes it turn round, and it is then that it arranges its ova with its posterior feet into two series.

The male dies immediately after having communicated with the other sex, but if the communication cannot take place, then the existence of the two sexes can be prolonged until the fifth day, but not beyond. We have noticed a female butterfly laying its ova during eight hours, and at the end of that time it died, as if from exhaustion. The number of ova was 162, which hatched on the ninth day.

The Caterpillar of the *Proceras* (Borer) is a true Tortrices, and of a great voracity; it belongs to the most destructive kind of nocturns.

Hübner has described and figured more than 400 species proper to Europe, where they exercise their ravages on different kinds of vegetables, either cultivated or wild. They are a true scourge upon the agriculturalist; and one has not yet succeeded in destroying them by suffocation.

This Caterpillar lives solitarily, under cover, in the interior of the cane, into which it penetrates as soon as its organs of manducation are strong enough to allow it to pierce through it. But when young and weak, it conceals itself between the leaves which are twisted and bound by means of a few silken threads; and it lodges itself under the parenchyma of the leaf. Later, it leaves it for the tender part of the heart of the plant. It is then that it begins to destroy the cane in a frightful manner, we have observed these caterpillars in captivity, they devoured a piece of cane top in the space of 24 hours, and when they had reduced it into humid dust, they abandoned it and tried to escape elsewhere—when another cane top was presented to these same caterpillars, they immediately attacked it, and in less than an hour they had disappeared into the interior, stopping up the opening with the refuse of digestion bound by a few silken threads.

When the caterpillar has reached its full developement, it is 12 to 14 lines in length, its motion is very quick and as easy forward as backward—the head is depressed, covered with a black and hard plate, capable of being drawn under the first segment of the neck, which is also covered with a plate of a paler colour than the head. The mouth is provided with two strong and horny jaws, bent inside and dentate at their extremity. Two mandibles with a lateral motion composed of four articles, of which the inferior are more distinct and oval, the three superior ones are hardly visible, moniliform, terminated by a sharp and hard appendice.

The labrum or superior lip, has a vertical motion, terminated by a very hard appendice in the shape of a lance, which assists the caterpillar in perforating the cane—all these parts which compose the moth are enclosed in a semicircular coriaceous membrane with two small antennæ, terminated with bristles.

The body of the caterpillar is composed of thirteen segments or rings, to each of the first three rings is attached a pair of scaly feet, the two following have none, the next four have attached to each, a pair of membranous feet, three segments are bare; the fourth and the last ring have a pair of caudal feet.

*(To be continued.)*

# ENQUIRY INTO THE USE OF THE SACCHARIMETER, AND OF CHEMICAL ANALYSIS FOR THE ANALYSIS OF RAW SUGARS.

The Minister of Finance in Belgium, instituted last year an enquiry into the value of the saccharimeter as an instrument of analysis for raw sugars. As a means of arriving rapidly at determined results, he addressed a letter to the principal chemical experts of France, and their opinions in regard to the comparative values of this instrument and of chemical analysis are embodied in the report we have before us. As this subject is one of the most important we can lay before our readers, we have decided to print it in full in our pages.

The following is the circular letter which was addressed to the chemical professors, &c., by the Minister:—

BRUSSELS, JULY 1ST, 1872.

SIR,

Allow me to avail myself of your knowledge and experience to elucidate certain questions which belong to the collection of the sugar tax.

You are aware that types based upon colour serve at the present time for the determination of the class in which raw sugars are to be placed, for the application of the excise duties; but experience has proved that in most cases the colour only is a very uncertain indication, and in commerce the saccharimeter, joined to chemical analysis, is at the present time the mode employed to determine the saccharine richness of raw beet sugars.

It happens that the powers between whom the Convention of November 8th, 1864, was concluded, will be shortly led, by the force of circumstances, to see if it can not urge the substitution of this latter method of classification for that actually in use; and to apply it to cane sugar as well as to beetroot. In view of this contingency, I ask you to be kind enough to give me your advice upon the questions contained in the note which I have the honour to send you enclosed in this.

Receive, Sir, &c.,

J. MALOW, MINISTER OF FINANCE.

## QUESTIONS.

1st.—What is the analytical method most generally employed by chemists for the determination of the saccharine richness of raw sugars: (A) from beet root, and (B) from cane?

2nd.—Does not this method indicate the saccharine richness of sugars more exactly than the colour method?

3rd.—Is the saccharimetrical method adopted by the sugar trade always sufficient for exact determination of the amount of raw sugar in refined sugar?

4th.—Is it often necessary to have recourse to inversion, and does this method present serious difficulties?

5th.—Is the manipulation of the saccharimeter easily acquired, and do the preparation of the solutions and the incineration of the sugar to be analyzed, become an easy matter?

6th.—How much time does it require to make a sugar analysis?

7th.—Are people, knowing little or nothing of physico-chemistry, but who are intelligent, apt to acquire the practical knowledge necessary for the use of the saccharimeter?

8th.—Are there no other less troublesome methods of analysis, quicker and more easily worked, and giving similar results?

9th.—What is your estimation of the method of analyzing sugar by means of a standard solution, more particularly of that of Barreswill, which relies on the use of a standard solution of copper?

10th.—What are the advantages and disadvantages of each of the above-mentioned methods?

11th.—What are the objections possible to be raised against the adoption of an analytical method for the determination of the saccharine richness of raw beet, and cane sugars, as far as the collection of the tax is concerned?

12th.—Is it possible to determine the absolute richness of cane and beet sugar, or the richness of sugar extracted in manufacture, by the new instrument (the polaristrobometer) of Wild?

13th.—Is this instrument easily used?

14th.—Does its employment completely dispense with the incineration and other operations used to determine the quantity of incrystallizable sugar?

## Enquiry into the Use of the Saccharimeter, and Chemical Analysis for the Analysis of Raw Sugars.

### Question I.

*What is the analytical method most generally employed by chemists for the determination of the saccharine richness of raw sugars: (A) from beetroot, and (B) from cane?*

### Answers.

M. Angenot, Antwerp. The analytical method most generally employed by chemists for determining the saccharine richness of raw sugars is the optical method; that is to say, one based upon the deviations which sugar solutions cause to the plane of polarization of light.

The apparatus most frequently used are either the saccharimeter of Soleil, or that of Soleil-Ventzke, or Wild's polaristrobometer, &c., descriptions of which are given in most books devoted to this special work.

Before speaking of the services rendered to manufacture and commerce by this method, we must remember that raw sugars (those from cane as well as those from beetroot) contain two varieties of sugar. 1st, *Crystallizable sugar* (that is to say, that which alone would be made more slowly into loaf sugar or pure candied sugar); and 2nd, *Glucose, or Incrystallizable sugar* (that is to say, incapable of crystallization, and forming, after refining, an integral part of molasses or syrups). Beetroot and cane sugars contain these two varieties, but in different degrees. In reality, in raw beet sugar there are only traces of incrystallizable sugar found. It is often completely absent from this kind. In examining our analyses books we find, that in 500 samples analyzed for the Antwerp commerce, there are only five in which the amount of glucose had exceeded $\frac{1}{1000}$th; the rest contained amounts varying from $\frac{2}{10000}$ to $\frac{7}{10000}$.

Cane sugar, on the contrary, was found to contain from 0 to 10 per cent. of glucose.

The conclusion, then, which we can draw concerning the optical method is, that by the aid of the saccharimeter the amount of crystallizable sugar can be determined in raw cane sugar as well as in raw beetroot; but it would be a mistake to attempt to determine glucose by the aid of these instruments, in bodies which contain less than 2 to 3 per cent., as there is a limit to the power of these instruments which, in practice, cannot be passed.

Again, the amount of glucose in raw sugar is nearly always determined by the standard solutions of Barreswill, Fehling, and Violette, which possess a remarkable delicacy.

To sum up, most chemists, in determining the saccharimetrical value of sugars, use both methods, the optical and the chemical method of standard solutions.

M. BOYARD, chemist, Brussels. The analytical methods in general use, among chemists, for determining the saccharine richness of raw beet and cane sugars, and for knowing their composition, consists in determining in the sugars—the water, the ash, the crystallizable, and incrystallizable sugar, and the organic matter, which latter is generally designated as *unknown*.

M. D. KONINCK, Liége. Raw sugar is composed of the following substances:—

1. *Crystallizable sugar.*
2. *Incrystallizable sugar.*
3. *Water.*
4. *Salts.*
5. Organic matter, for the most part incompletely known, and called *undetermined;*

Beetroot and cane sugars being, in a chemical point of view, the same, similar methods are applicable to both.

A. *Determination of crystallizable sugar.* The only process in use for the determination of the crystallizable sugar, both among manufacturers and chemical-experts, is the polarimetric method based on the optical properties of sugar solutions.* Among the polarimetric instruments invented, the three best and only ones in use are—

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* See page 283, *et seq.*, of the *Sugar Cane* for June.

Soleil's saccharimeter.

Ventzke's saccharimeter, which is only a modification of Soleil's.

Wild's polaristrobometer.

These three instruments, when made with care, furnish, in the hands of one accustomed to their management, equally good results, if the solution to be examined is decidedly colourless. When the sugar solution is coloured, as often happens, the polaristrobometer is to be preferred. It is easily understood that the influence of colour would be greater in the case of the saccharimeters of Soleil and Ventzke, instruments based on the equality of tint of the two parts of the field of vision, than in that of the polarimeter of Wild, which is based upon the disappearance of the black rays produced by interference on a coloured ground.

It may be added in favour of Wild's apparatus, that its construction is simpler, that an exact graduation is more easily obtained and controlled, that exactitude in this case depends, less than in the others, on the nature of the sight of the observer, and also, that its management is more easily acquired.

B. *Determination of incrystallizable sugar.* The analysis of incrystallizable sugar is done volumetrically, by means of a standard alkaline copper solution. This method is known as that of Barreswill. I will speak of it shortly in greater detail.

In beetroot sugar the proportion of incrystallizable sugar rarely exceeds $\frac{2}{1000}$, the determination is thus of little importance; but in cane sugar, this amount often rises to 4 and 5 per cent.

C. *Determination of water.* The water is determined by drying a known weight of the sample to be analyzed, at a temperature of from 105° to 110° centigrade.

D. *Determination of the salts.* The salts contained in raw sugars are the salts of organic acids (such as oxalic acid, malic acid, tartaric and citric acids), to which may be added small amounts of chlorides and sulphates. The base of these salts is potash, mixed with a little soda and lime.

It is practically impossible to determine the quantity of salts contained in raw sugars; it is sufficient to determine the ash, that is to say, the inorganic matter which remains as residue after incineration.

The greater part of the ash obtained by direct incineration is composed of carbonate of potash, an easily fusible salt, which, on account of this property, renders the operation a difficult one, as it envelopes the last particles of carbon, and thus secures them against the action of the air. It is, as a rule, preferable to treat the sugar before incineration with concentrated sulphuric acid; the residue obtained in this manner is composed of potassium sulphate, which, as it only melts at a temperature higher than that required for the combustion of the carbon in sugar, allows the incineration to be completed more rapidly.

The chemical equivalent of sulphuric acid is higher than that of carbonic acid; thus the same numerical result is not obtained in the two cases, but the results furnished by either of the methods are as consistent among themselves, as are the results obtained by the other.

Practical calculations are based on the results of direct incineration, and it is considered, after Scheibler's experiments, that the numerical results obtained by incineration after treatment with sulphuric acid are $\frac{1}{10}$th too high. It is thus necessary, in order to compare them with the first, to multiply them by the co-efficient 0·9.

E. *The indetermined matter* is calculated by subtracting the amount of the determined elements from 100.

M. Donny, Ghent. The optical saccharimeter is usually employed by chemists to determine the richness of raw sugars.

M. Dufour, Antwerp. The optical saccharimeter is the method most generally employed just now.

M. Gaillard, chemist, Tirlemont. Direct determination of a prepared solution by the saccharimeter. Determination of the per-centage amount of incrystallizable sugar, by the inversion of a portion of the sugar solution and a redetermination by the saccharimeter, or by means of standard solutions and weighing the filtered deposit.

M. Groulard, Liége. The method most generally employed by chemists for analyzing beetroot sugars is the optical saccharimeter; respecting cane sugars, it is customary to sell them according to type, but they can never be analyzed by the same method.

MM. HACCOUR AND PAULY, Antwerp. The saccharimetrical richness of raw beet and cane sugars is most frequently determined by polarimetrical analysis, and inversion by the necessary standard solutions, especially for cane sugar.

M. HANUISE, professor, Mons. Saccharimetry in both cases, comprising: the determination of crystallizable sugar by means of the polarimeter, of incrystallizable sugar by standard solutions, by dessication and incineration.

The produce is determined by multiplying the amount of ash by 5, and subtracting the product from the quantity of crystallizable sugar found.

M. LEMBOURG, Quiévrain. The method most generally employed for determining the saccharimetrical richness of raw beet and cane sugars, is that which is known under the name of the optical saccharimeter, which is based upon the polarization of light, and upon the property which sugar solutions possess of deviating the rays of polarized light.

M. SEMMEL, Ghent. The method of the optical saccharimeter is used in connection with the determination of the ash for both A and B.

M. WACHSMUTH, Antwerp. The analytical method for determining the saccharine richness consists—

*For A.*—Beetrooot sugar:

1st. In the use of a polarizing instrument.

2nd. In the determination of the incrystallizable sugar, which is almost always present in small quantity in these sugars.

3rd. Incineration.

And 4th. By the determination of the amount of moisture.

*For B.*—Cane sugar:

The method is the same; but more frequently those interested dispense with analysis, and buy according to colour.

I may add here, that, according to the accounts of M. Dax, sugar merchant in Havana, who passed last year with me, so as to become acquainted with the method of determination of incrystallizable sugar, he has commenced to buy cane sugar in Havana according to the polarimetric analysis only.

*(To be continued.)*

## THE MOST THICKLY-PEOPLED COUNTRY ON THE GLOBE.

The island of Barbadoes, in the West Indies, is more thickly-peopled than England with her 22,000,000, Belgium with her 4,000,000, and more thickly-peopled even than China with her 300,000,000. With a superficial area of only about 166 square miles, without any large towns, without manufactures of any description—a purely agricultural colony, she actually supports a population of 180,000 souls, or over 1084 to the square mile! To find the means of sustentation for this cooped-up mob of people she has brought under cultivation nearly every inch of her 106,470 acres of culturable land; and to the superficial observer she presents an aspect of wealth and prosperity unexampled in the West Indies, and hardly to be surpassed in any other part of the world. A little reflection, however, shows that in this very prosperity lies her danger as a settled community. In a country where the maximum of production has long since been reached, while the population is still on the increase, there must be a tremendous waste of labor, and a vast amount of destitution; the people must press with terrible closeness on the means of living; and when, as during the past year, one of the ever recurring droughts, to which the arid surface of the country is subjected, sets in to blast the hopes of the planter, to burn up his fields, and leave him without the means of employment for his labourers, the chronic distress becomes dreadfully intensified and the condition of the people positively a struggle for existence.—*Shippers' Monthly Circular.*

## SUGAR AND SUGAR.

TO THE EDITOR OF THE "MANCHESTER GUARDIAN."

SIR,

There is probably no word in trade phraseology more maligned than the word "cheap." Every trade stripling knows, or thinks he knows, the comparative adjective cheap, cheaper, cheapest. But the question is, is beetroot loaf sugar cheaper, or as cheap, or anything like as cheap, as cane lump at the prices quoted to a consumer? Sugar we know is the decoy duck of grocers. In the name of the Prophet "Sugar!" The household gods and the conscience even of grocers, and they are all honourable men, as Marc Anthony said of the killers of Cæsar, do not condemn them for selling beetroot sugar for cane sugar; it is offered to them at a lower figure by French agents, who scour every town in England, Ireland, and Scotland; it is not their business to tell their customers that for household purposes it is at least 30 per cent. inferior to cane sugar, and not one customer in a hundred, probably not in one thousand, can see at a glance the optical difference between these two sorts of sugar, and as appetities vary with the temperature, and as the sorts of table food vary from day to day, the difference in the saccharine power between cane and beet sugar is not suspected by *materfamilias.*

Having good economic reasons for ascertaining the nutritive value of all sorts of food, sugar included, I found out some years ago—though I must confess that it was a three months' mystery—that beetroot sugar added quite 30 per cent. to my sugar account. Not being in the habit of investigating the mysteries of the sugar pot, I did not even suspect the presence of beetroot sugar. Sugar was ordered, and sugar was supplied by my grocers, and "no questions asked," and, of course, no information given. A man may munch beetroot sugar on the boulevards of Paris and under the Pavilion of the Palais Royale, and despise there the floury chalky-looking article without suspecting that it will soon be every day on his own table at home. So it was, but as a very dear and bad article; no beetroot sugar has been on my table for five years past, and so long as I can get cane sugar the quintessence of beetroot never shall again be admitted to my family stores.

But the inferiority of this artificial sugar—I speak as a *restaurateur*, not as a chemist—does not end in dearness and badness. Let any man or woman fill two large cups with tea, and put in each cup precisely the same weight of sugar, one of cane and the other of beetroot sugar, and taste the saccharine difference. Let her ladyship then add two teaspoonfuls of milk to each, and she will at once see how detestably duller and darker the colour of the beetroot cup is. Cream will hide the difference. It improves the blackness or darkness of coffee. Every good housewife who visits London will have remarked the flat taste, the dark and muddy look of the tea she drinks in London. It is tea *cum* beetroot.

From my further recollection and experience of beetroot-sugared tea, I will put it to the suspicion or thought of medical men whether beetroot sugar used with tea is not one cause of the greatly increased diarrhætic affections now much more common in England than they were a dozen years ago. From my own convictions this is the case. Diarrhætic affections are more common in France than in England. How is that? And I am informed that this complaint is more common in England than formerly. Our English food is drier than that of France; but our present food is as dry as, if not drier, than it was ten years ago, when wages were less, and when good bread and meat were consumed less generally.

Good cane sugar is driven out of the market by inferior beetroot sugar, and, since the sugar Convention for the suppression of bounties on the exportation of refined sugar was signed, the number of loaf-sugar makers in Great Britain has fallen to about one-tenth of what it was. The fact is that beetroot sugar, greatly inferior in every sense, is offered and sold to grocers at a lower figure than cane sugar, but is propped up in price by the superior price and value of the latter. It is the interest of grocers to "push" beetroot sugar; first-class grocers will not sell it, as they will not sell East India sugar, whilst public attention has never been directed to the difference of value between the two sorts. But, as our treaties with France and Holland and our own laws bind us against differential duties, I may be asked, "What is your remedy?" I answer, compel every grocer to label "beet sugar" in a fair and honest manner, as he labels "chicory" *versus* coffee. As matters stand, 99 householders out of every 100 are deceived in their purchase of sugar. They think that they are buying and consuming refined cane sugar, which their fathers and themselves have hitherto been accustomed to buy and consume, while, in fact, they are using an inferior substitute—and, mixed with tea, I believe an injurious substitute—for cane sugar. Frenchmen and Dutchmen know their business well; we ought to know ours. Label their saccharine rubbish with its own name. Do this, and then the International Sugar Convention may "say grace!" To assure you that I am not a British sugar refiner, and as evidence of my sincerity, I beg to affix my name and address.

I have the honour to be, Sir, your faithful servant,

Isaac Gregory.

*Merchants' College, Blackpool.*

We reproduce this letter from the *Manchester Guardian*, as the point on which it touches is interesting to every one. Still we must not allow its sweeping accusations and affirmations to frighten us. Mr. Gregory finds a very great difference in the sweetening powers of beet and cane sugars. This may be, we have never seen any experiments tried on this subject, but we are informed, on the authority of a man of high standing as a refiner, that such a difference does exist. However, another thing must be borne in mind, that is, that a great difference exists in ordinary cane sugars, and we need not go very far to find a satisfactory reason for this.

The sweetness of a solution or substance depends upon the amount of sugar in it. If the sweetness of one falls below that of another, we naturally conclude that the amounts of sugar present are different. Pure sugar is the sweetest thing we know; and if two samples are sold as being of the same sugar, and the one falls below the other in sweetness, we naturally conclude that one is purer than the other. The sweetening power of beet will be as great as that of cane, although a larger amount of it may be required to give that sweetness. Mr. Gregory must distinguish between *purity* and sweetening power.

Again, there are certain conditions necessary to be observed before anything can be said about them. Did Mr. Gregory try the sweetening power of the sugar he purchased in a cold or hot solution? If in a hot, then the results are comparatively valueless, as the sweetness can only be properly determined in a cold solution. Also a sugar with a smaller amount of saccharine richness—that is, a less pure sugar—cannot be tasted after one containing a larger amount of sugar. The taste has become to a great extent vitiated by the stronger sensation. We have before us results, which may, perhaps, some time be laid before our readers, showing the difference in sweetening power of cane sugars. Suffice it to say, for the present, that there is such a difference.

As for the physiological effect of beet sugar, that is a point very difficult to determine. It is dangerous ground we are treading upon when we lay the "diarrhœtic affections" prevalent in France to the amount of beet sugar consumed by the two countries! This is bringing things to a decided climax! As long as any two countries are *two* countries, and not one, so long will the difference be between the peoples.—Ed. *S. C.*

## FRENCH SUGAR DUTIES.

The Paris correspondent of the *Manchester Guardian* writes: "The heavy duty laid on sugar was to have produced during the past year 170 millions, whereas it has produced only 105. This disagreeable fact has induced Government to lend an attentive ear to the complaints of the raw sugar manufacturers against the refiners, whom they make responsible for the greater part of the 65 millions wanting. No article of general consumption has been so much legislated upon, nor in such a bungling manner, as this one of sugar. Where the English refiner makes a penny profit, the French refiner pockets at least sixpence. The latter can, therefore, drive the former out of your own markets; and to a very great extent he does so, the French Government unconsciously paying the price of the French refiner's victory. The makers say to Government:—'Billet the excisemen on the refiners as you have billeted them on us, and let them tax, not the raw material which we send into the refinery, but the sugar-loaf ready for consumption which the refiner sends out of it.' England and Holland not only consent to this, but they ask that it should be done. Belgium is not opposed to the change. Government replies that it would be too troublesome, and that the officers of excise would not be equal to this increased work. The excise can find sufficient men to inspect and rate the produce of 512 sugar mills, and is unequal to the inspecting and rating of 33 refineries; for that is the proportion between the makers and the refiners. What Government proposes is a system which has been tried and given up already in other countries—that of the saccharimeter and chemical analysis; to practice which it would be necessary to have an experimental chemical analyst permanently attached to each establishment. The refiners are, of course, willing to accept the Government project as a means of prolonging the duration of their golden harvest, and staving off the common-sense and simple plan of the makers, which would put an end to it. The latter, however, are backed by the whole agricultural interest of France, and by the support of England and Holland. The Committee, too, appointed by the Assembly to report on the two bills is favourable to the taxation of sugar as it leaves the refinery."

# NEW METHOD FOR THE DIRECT DETERMINATION OF THE AMOUNT OF REFINED SUGAR IN RAW SUGAR.

### BY DR. C. SCHEIBLER.

*(Translated from the Journal des Fabricants de Sucre. By H. C. Humphreys.)*

(Continued from page 263.)

## REAGENTS AND APPARATUS.

The necessary reagents for the analysis are as follows:

I. Alcohol of 85-86° mixed with acetic acid (50 c. c. to each litre of alcohol) and saturated with sugar. For this a good refined sugar is taken which is powdered and introduced into a bottle, the above-mentioned solution is poured in it is hermetically closed, and shaken frequently during several days.

II. Alcohol of about 92°.

III. Alcohol of about 96°. Alcohols II. and III. have no addition of acetic acid, but are saturated with sugar, as was the case with the 1st solution.

IV. Absolute alcohol, alcohol which is of 99·5° is sufficiently concentrated. This is neither charged with acid nor saturated with sugar.

After having saturated the solutions I., II., and III. with sugar, at the ordinary temperature, taking care to shake frequently, we place them in a number of bottles for preservation. The inner surfaces of these bottles should be previously covered with a coating of sugar crystals. This is easily accomplished, if we fill the bottles with a boiling saturated solution of refined sugar in alcohol of 85-86° and let them stand in a cool place for several days. The sugar will thus form a crystalline coating over the whole surface. It is perhaps still more practical, although I have never yet attempted it, to fill the bottles with an aqueous solution of sugar, capable of crystallizing. It is necessary to allow the crystallization to take place with the bottles in an inclined position. If not, the largest portion of the sugar will crystallize uselessly in the bottom of the bottle. It is also advisable to first etch the inner surfaces of the bottles with hydrofluoric acid, in order that the crystalline crust may adhere better and not become detached. The saturation of the alcoholic solution is easily and surely obtained by means of a Liebig's condenser.

The bottles once well crusted allow of a very long use without its being necessary to add a new crystalline coating of sugar. According to my own experience, it is improbable that the crystals diminish after an usage of six months or more, when pains are taken to replace each time as much of the solution as has been drawn off for an analysis. I myself have not been obliged to repeat this operation. The operation of coating should not be put off, as this precaution alone offers all the guarantees of a state of the absolute saturation of the reagents, whatever may be the change of temperature in the laboratory. Every variation of temperature naturally acts at first on the sides of the bottles. But the solution thus finds at the same time the means of re-saturating itself or of disposing of its sugar. The precaution of suspending crystals of rock candy in the solution does not produce that perfect saturation, the essential condition for the accuracy of the results. The apparatus which I employ for the treatment of sugar by the above-mentioned solutions, consists simply of glass tubes, such as is represented in Fig. 1. They are composed of a part *a b*, quite large, open at the top, about 20 millimetres in diameter and 15 centimetres in length, ending in a drawn-out tube. In the bottom of the larger tube there is introduced a piece of soft felt to serve as a filter. The tare of these tubes with their filters is previously determined. It is well to have a number of these tubes marked for the purpose of carrying on simultaneous analyses. For this purpose, as well as for all the weights hereafter to be mentioned, a balance which is sensitive to one centigramme is sufficient.

Figs. 1 to 4 show the apparatus in its simplest form; Figs. 5 and 6, the most convenient dispositions to be given to a number, when used by professional chemists or persons having numerous and daily analyses to make. I will endeavour to explain the manipulation of the more simple apparatus; that of the compound apparatus is similar.

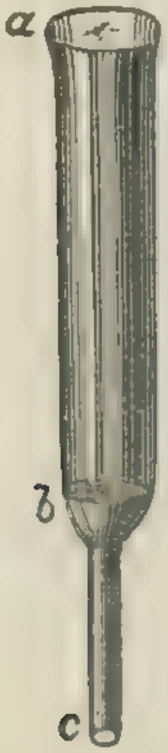

Fig. 1.

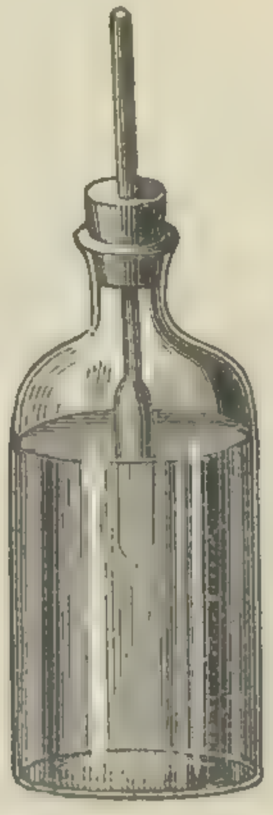

Fig. 2.

### MANIPULATION.

The first care must be to select, from the raw sugars to be

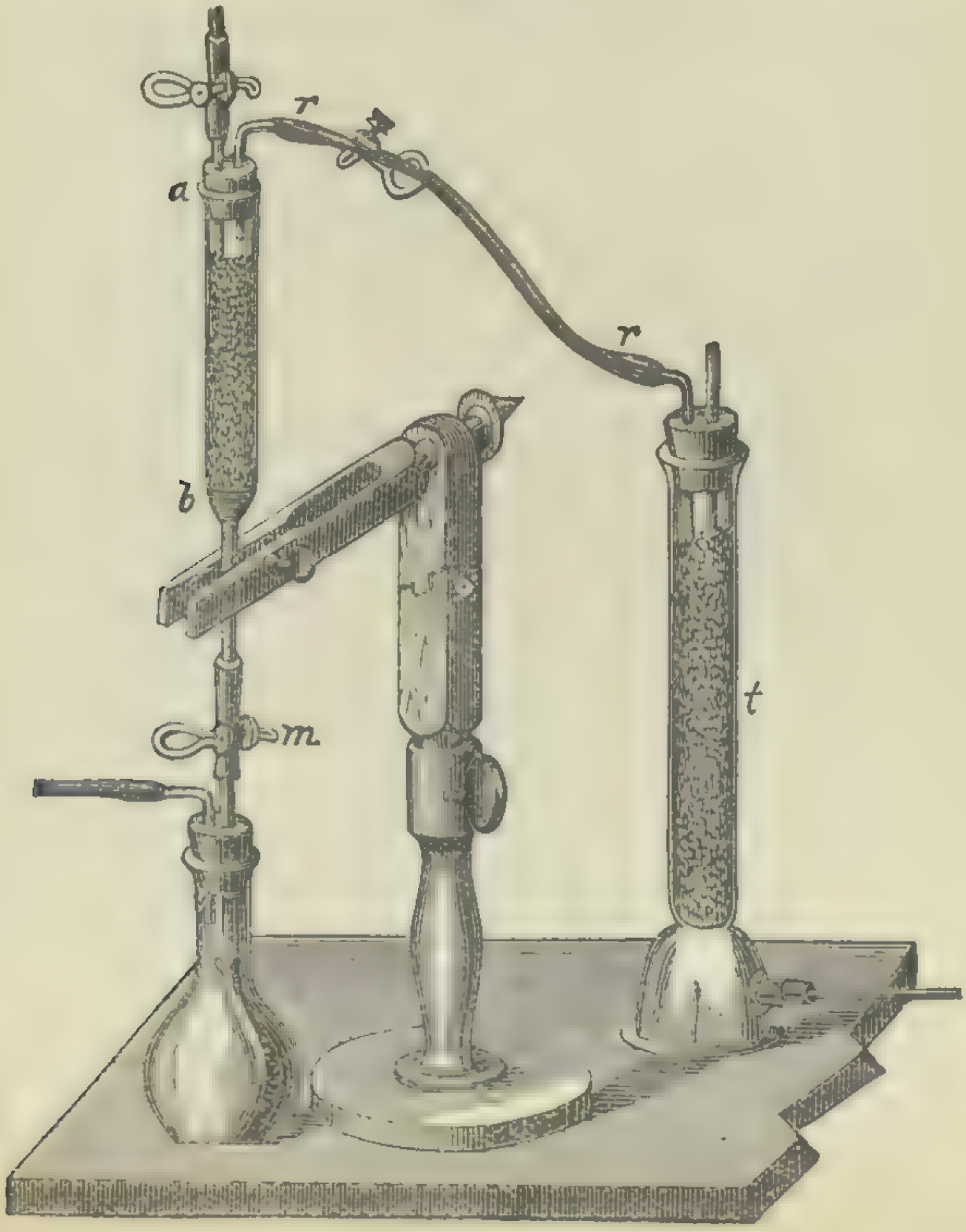

Fig. 3.

analyzed, average samples, the lumps being carefully ground as in the polarimetric analysis. Then one of the previously weighed tubes is filled to within an inch of the upper extremity with the sugar to be analyzed. It is weighed and the weight noted. The tubes are capable of holding about 20 grms. of sugar. Then the lower extremity *c* is connected by a rubber tube with a glass stopcock or a pinch cock, to a flask closed by a rubber stopper with two glass tubes; this disposition is shown by Fig. 3.

The cock being closed at *m*, absolute alcohol (solution No. IV.) is run into the tube by allowing it to slowly trickle along the sides of the glass, in such a way as to saturate the whole sugar. This is better accomplished by means of a pipette (of about 19 c.c. capacity), which is shown in the flask, Fig. 2.

For 15—20 minutes this liquor is allowed to remain so as to give time for the alcohol to combine with the water of the sugar. After that the alcohol is allowed to flow of by *m*, the last traces being removed by means of a Bunsen's pump, a Scheibler aspirator or other apparatus.* During this operation and all subsequent, air charged with the vapour of water must not be allowed to enter the filter tube; this is prevented by only allowing air to enter which has been dried by a chloride of calcium apparatus, *t*. The air is brought through the communicating tube, into the tube *a*.

After this there is poured on solution No. I., then No. II., about 10 cub. cent. of each, by means of their respective pipettes, which are allowed as before to run off through *m*. This washing separates the absolute alcohol adhering to the sugar, which is finally saturated with sol. II. After this latter has been drawn off as carefully as possible, by means of the air-pump, the stopcock *m* is closed, the pump is detached, and the tube is filled with the acetic acid solution No. I., by allowing it to gently trickle down the sides of the tube, until the sugar is completely covered. The sugar is left for 15-20 minutes, sufficient time for the solution of all impurities of the raw sugar, the molasses, during which time the mass of sugar diminishes in volume, and settles.

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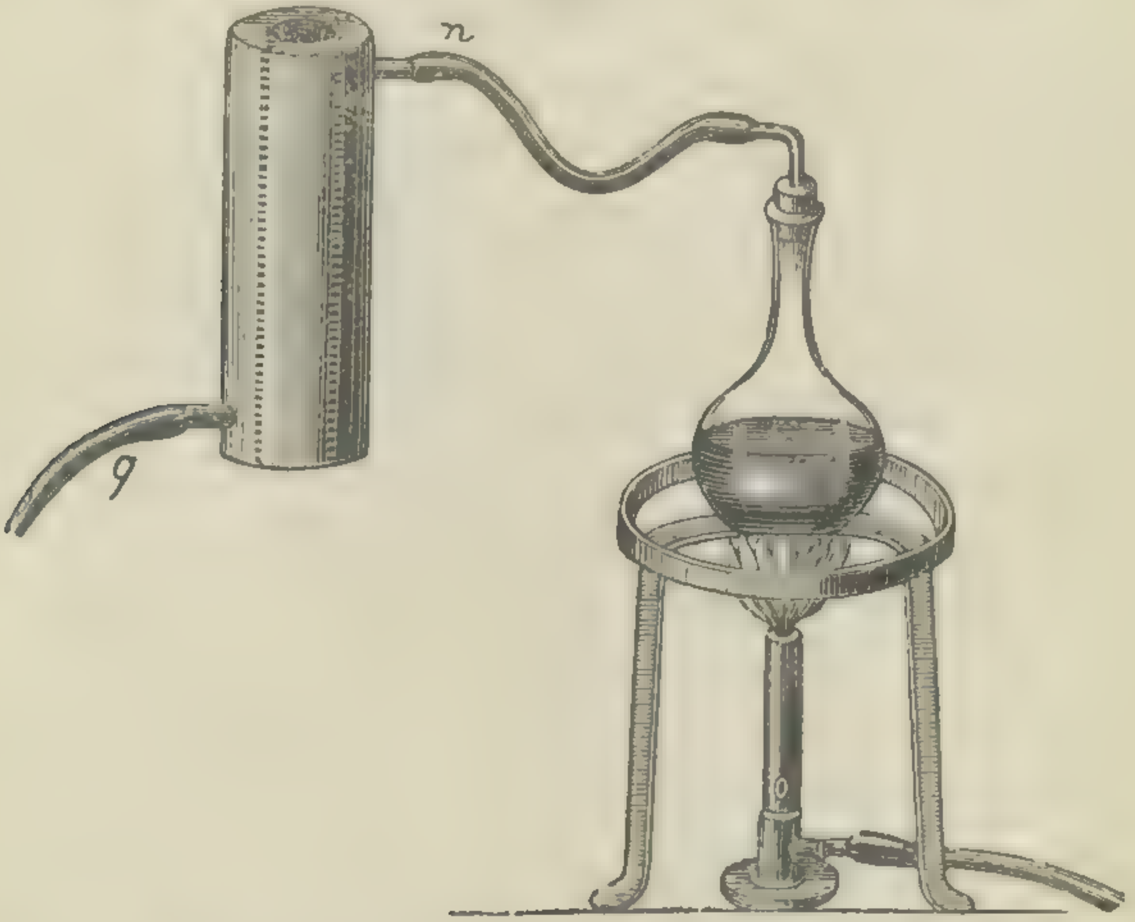
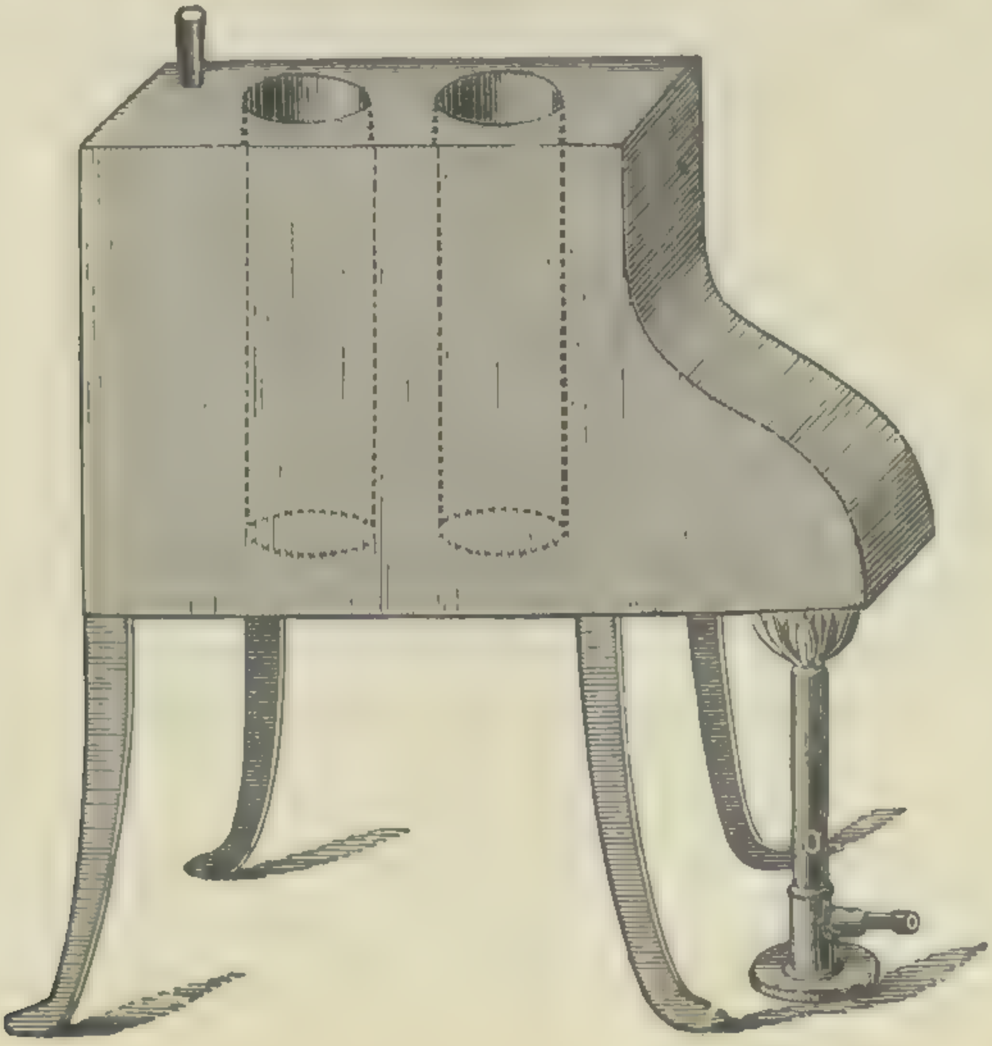
* Besides water, the alcohol takes up small quantities of foreign substances, such as fatty bodies, alkaline salts, alkaline salts of fatty acids (butyric, valerianic, &c.)

Fig. 4.



From this point the operation may be conducted in two ways, either by allowing the solution to entirely filter off, the last traces

Fig. 5.



being removed by means of the pump, or by allowing it to drain off gently without the use of the pump, care being taken to add new quantities of the acetic solution, to replace that which has filtered off. Whichever may be the manner of washing employed, it is always necessary, in order to insure the complete purification of the crystals, to pass three or four times the volume of the acetic acid solutions, according to the quality of the product. The upper layers are first purified, and the colouration of the washings is an index of the progress and completion of the operation. There is thus obtained, in washing samples of higher grades, crystals possessing a brilliant white colour. Secondary products give a yellow or light brown residue.

After the elimination, by the acid solution, of the soluble portions of the sample, which is shown by the nearly or entirely colourless washings, which it is well to preserve, an equal volume of each of the solutions II. and III. in the order of the series, is poured upon the sugar. The strong solution has thus been replaced by a weaker one, and all the acetic solution adhering to the crystals has been removed, the last solutions giving a perfectly neutral reaction. The operation is finished by a double washing with absolute alcohol IV., in order to obtain perfectly pure residues, and to prepare them for desiccation. Meanwhile the apparatus remains closed, so that the different solutions are in no wise altered by absorption of atmospheric moisture, and the alcohol attached to the crystals may be rapidly removed by a current of warm air. By this means there is at last obtained a mass of pure dry sugar crystals, which, after cooling, is weighed.

To rapidly effect desiccation, I make use of a metal cylinder with double sides, Fig. 4, in which the filter tube is placed. By means of the flask a jet of steam is introduced into the cylindrical envelope, having its exit at *g*. The tube and crystals are soon warmed, and at last the absolute alcohol is entirely dissipated. During the whole operation a current of air is drawn through the apparatus, by attaching it to a pump which draws away the vapour of alcohol formed, and the completion of the desiccation is evident when no more drops of alcohol appear at the end of the tube *s* of the filtering flask. The metallic cylinder is removed, and the tube allowed to cool, in order that the weight of the purified sugar may be determined. The desiccation takes at the most 10 to 15 minutes, and the whole operation, that is our assay, consumes, according to the quality of the sample, 1½ or, at the most, 2 hours. During this time, four to six or even more analyses may be undertaken, and finished, provided that there are a sufficient number of filter tubes. This method consequently needs no more time than a polarimetric analysis made with care, and there is opportunity given to industrial and analytical chemists to occupy themselves with other analyses, with polarization, etc., during the leisure afforded by this method. Besides, with the exception of the first and last weighings, all the manipulation may be conducted and carried on by an assistant, an intelligent boy, for example; for the reasons that the results of the operation control themselves by the composition of the final product, and by the total amount of wash liquors employed, being about 110 to 120 c.c. for the whole operation.

*(To be continued.)*

## Correspondence.

### THE SUPERIORITY OF CONCRETOR TRAYS OVER BATTERIES AS EVAPORATORS.

Edinburgh, 13th May, 1873.

The Editor of "The Sugar Cane."

Dear Sir,

I recently visited some extensive sugar estates in the East, and have just received the results of an experiment which I requested one of the managers to make *personally* for me. The experiment was made on two contiguous estates, almost identical in character of soil, &c. Both estates manufacture vacuum pan sugar, but on one (No. 1) estate, the preparatory evaporation is effected by two sets of Fryer's patent Concretor trays, and on the other by two open batteries. These batteries are two continuous pans, separated by plates into several compartments, and the liquor flows by gravitation through valves at the foot of each division plate. The experiment was made to test the difference in loss of colour during the evaporation on the Concretor trays and the batteries. The following is a copy of the report just received:—

"The juice from the filter bags at No. 1 was a fine bright "yellow, clear as amber, and after passing over the Concretor trays "only required *two* parts of water to one of syrup, to reduce it to "the original tint of the juice.

"The juice taken from the clarifiers at No. 2 was clear, but "with a green tinge; it turned very dark in the battery, and "required *five* parts of water to one of syrup."

On the first estate the clarification is conducted on the clay process, similar to that practised in Demerara; and on the second one, on the ordinary "cracking" process. On No. 1 the juice also passes through a simple arrangement of bag filter, fitted horizontally on the top of the receiving tank. This accounts for the difference in tint of juice, and partly also for the subsequent difference in loss of colour; but there is no doubt that the difference is *principally* due to the juice on the Concretor trays being exposed to the heat only in a thin stream, to the greatest heat when lowest in density, without mixing, and for a much shorter time than in the batteries; where it is exposed in large volumes, to the greatest heat when highest in density, and mixed.

I may add my own opinion, that the complete Concretor would show even greater advantages than the trays, as a preparatory evaporator to the vacuum pan. This opinion is confirmed by the experience obtained during several years at the factory of the Viceroy of Egypt, where the Concretor was found to give syrup of a better colour than the double effect vacuum pans. When the whole Concretor is used, the juice is only concentrated to about 16° B. on the trays, and at this density the syrup is very mobile, and even the lowest trays are well filled with liquor. The cylinder is a powerful evaporator, and brings the juice up to 26° B. without injury to colour, and with great economy of fuel. The complete Concretor is thus much more powerful than the trays alone, but it is too much to expect that the trays alone can rival the triple effect in the colour of the juices concentrated.

Hoping the results of this experiment may interest some of your readers,

I remain,
Yours truly,
H. O. Bennett.

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To the Editor of the "Sugar Cane."

Sir,

In one of the speeches of the Chancellor of the Exchequer, he insinuated that exporters of refined sugar from this kingdom obtained a bounty from the Exchequer, and some of them were really dissatisfied because the reductions in duty limited this premium. This dissatisfaction, I take it, is one of the errors into which those who speak of the sugar trade have fallen, as Mr. Lowe bluntly asserts. Suppose this alleged premium on export to be true, and to amount to sixpence per cwt.: the sugar refiners would then have paid to the customs in 1872, £3,250,000, and would have received back on the total amount of sugar exported in excess of the amount paid not £16,000, *about a month's interest on the duty paid.*

Mr. Lowe seems to possess the microscopic eyes desired by Sam Weller, "Compound double magnifyers of hextra power," to discover such an abstraction from the revenue; but he has used all his "inertia" to leave the Convention with France undisturbed though the same refiners have shown incontestably the following: That the French duties were five times as heavy as those of England. That the premium on export is therefore five times greater for the French refiner. That in 1872, 89,000 tons of foreign refined sugar were exported into England; of this the greater part was French, and of the remainder a premium on export was received in proportion to the amount of duty.

Thus the refiners who are alleged to have received £16,000 have to compete with the French and others who have received from their respective Governments for sugar exported to England alone, an amount not less than £200,000. But this is not all: the premium on export is much increased by the use of beetroot sugar so abundant in France, and still further increased by the art of sophistication of beet sugars which enables the refiner to pay too low a duty on the raw. But in addition to all this, the English refiners are required to pay in advance the duty to their Government on behalf of the consumers, whilst the French refiners receive several months' credit, *the gain to one French refiner alone, from this source, is more than three times that of the total aggregate premium on export from this country.*

Mr. Lowe seems disposed to protect trade, but that is only the trade of the foreign refiners, and to see the English loaf trade entirely disappear. It is almost annihilated at the present time.

Mr. Lowe told the House of Commons that upon no subject were so many lies told as upon that of sugar. This insinuation against those concerned in the production, refining, and sale of sugar, is as offensive as it is untrue, but perhaps as a diplomatist, he does not consider lying to be a vice.

Had Mr. Lowe made this choice statement at the commencement of his remarks on this subject, it might be that his sweeping assertion would have been more open to dispute.

Yours truly,

H.

## EMANCIPATION OF SLAVES IN PORTO RICO.

The following abstracts of a letter from a valued correspondent in Porto Rico have just been brought before our notice, and we think that at the present time they will repay perusal.

"I chanced," he writes, "to be here when the telegram came, stating that the Cortes had decided on the immediate abolition of slavery in Porto Rico, with orders to the Captain-General to make it public immediately.

"In giving you an account of what passed, I merely give you a synopsis of what occurred throughout the island. My residence here, acquainted as I am with every part of it, and my intimacy with all parties, makes me a pretty good authority; moreover, I am not biased by any party feeling—my proclivities were, if anything, rather in favour of the Conservatives, but, since the Liberals have scouted all wish for separation from Spain, and have shown so much moderation and good sense, in spite of the exasperation they daily suffered from the Conservatives when their party was strongest in Spain, and since the outrages committed here, most certainly by the Conservatives, to try and throw odium upon their opponents, whatever little Spanish Conservatism I had in me, I have washed my hands of.

"On Tuesday, the 1st April, the telegram was communicated to the various military commandants or to the *Corregidores*; by ten o'clock in the morning every individual, free or slave, knew it. I was staying with ——, and he drove round in the afternoon to his estates, had all hands called up, told them they were free to do as they pleased, they gave a shout, *Viva Espana*, *Viva la Republica*, *Viva la Liberta*, and there was an end of it, they all went back to their work.

"I must tell you they had commenced cutting canes that day with the intention of putting about at midnight, and they did it. I had occasion to visit these estates during the three or four days following, and everything was going on as if nothing had happened, the managers assured me they never had had so little trouble. No stranger unaware of what was passing would, if passing through those boiling houses, have fancied that the men he saw there working were in any other position that what they had been all their lives,—and don't for a moment imagine our Spanish negro inferior to his brother French or English negro. I find, as a rule, that the negro in character assimilates himself very much to his rulers. There is as much difference in the character and habits of the negro of the three nations, as there is between the whites. Our negroes here are sober, frugal, but fond of dancing and gambling, and of the three races, if such they may be called, I certainly think more of the Spanish negro than the others. As a boy I witnessed the freedom of the English negro, and as a young man that of the French. and I shall certainly never regret having remained to be an eye witness of what has passed here.

"As a rule, slaves have been kindly treated in Porto Rico, I do not deny there have been some few exceptions, but for some years past slavery was considered doomed, none but a few of the rank Conservatives regret it, and the general feeling is that of relief that it is done away with, for of course many have their doubts if it would, or would not, occasion trouble. But our slave population (30,000) was a mere bagatelle compared to the whole amount of the inhabitants (625,000); a great portion of the sugar cultivation was always done by free people, and the free and the slave were accustomed to work side by side in the cane-row—this was never the case in the French or English islands.

"I suppose were you to go to the bottom of matters, you would find few whites here, except foreigners, of course I include Spaniards from the Peninsula and their immediate descendants, but nominally our white population musters strong, all are whites who are not too black to give the lie to it, and even many of these do not admit they are not, and money makes the second generation white.

"The proclamation here was immediate freedom, the slaves freed having to remain as hired servants to their former masters, or choose others; in the event of not wishing to hire themselves to their former owners or electing others with whom to bind themselves for the three years Government takes charge of them.

"We are of course to receive compensation for them, Spain is too liberal a nation to take people's property away without paying for it. The Cortes voted 7,000,000 dols. (about £1,500,000,) to pay for the slaves emancipated, does not this *sound* wonderful, £1,500,000 to be paid to the owners of 30,000, bondsmen yesterday, freemen to-day?

"But where are the £1,500,000 to come from? We are to have the honour of being allowed to raise a loan for this amount, and afterwards tax ourselves to pay it; but our taxation resembles very much your income tax, easily put on to stave off a passing difficulty, but somehow or other the difficulty passed, the tax still remains, it will not shake off "no how," and the general feeling here is, we are better without the compensation and the tax; but of course Government must be generous, and there will be too many people interested in fingering the money for them to allow us to presume to know what might be beneficial to us.

"You must know the island pays its own expenses, no money comes here from Spain, and somehow or other there is something mystical about the surplus. We know such a thing ought to be, we know it has existed, we feel confident the taxes have produced in such a year so much, and we know the expenses were but so much, but the surplus is never forthcoming, we presume of course it goes to Spain.

"After the hurricane and earthquakes of 1867, the Spanish Government, taking into consideration the unfortunate state of the country, relieved us of the taxes on provisions and lumber, a tax which produced over 500,000 dols., (about £100,000,) of course they made a great boast of it, but, as we pay all the expenses of the Government, from the Captain-General down, and must find wherewithal to do it, or they remain unpaid—at least the small fish do—it happened twelve months after the Treasury was bankrupt and the poor employées starving. Treasury bills were sold, these were to be taken in payment at the different custom houses, and were of course willingly purchased by capitalists, who passed them over to the merchants. The subsidio was trebled, taxes were put on the exports, and in two years the Treasury notes were taken up and there was a surplus in the Treasury. Since then the expenses of the country have not been greater, neither have the taxes been reduced, but it is a mystery where the balance goes.

"In Ponce things are more unsettled than down the coast, the free negroes asking higher wages than planters feel disposed to give them. Free labour has always been comparatively scarce in Ponce and the estates were generally well supplied with slaves. Free labour was worth from 62½ to 75 cents (3s. to 3s. 9d. sterling) per day, and in the works a dollar (4s. 2d.); of course, planters cannot afford to pay this price for all hands. On some estates where they were not over well treated they have left and made contracts with other planters."

### Stocks of Sugar in the Chief Markets of the World on the End of March, for Three Years, in thousands of tons, to the nearest thousand.

| | 1873. | 1872. | 1871. |
|---|---|---|---|
| Great Britain | 118 | 92 | 87 |
| France | 136 | 72 | 118 |
| Holland | 57 | 43 | 17 |
| Germany (Zollverein) | 30 | 21 | 48 |
| Six other *entrepôts* | 7 | 5 | 7 |
| Total in Europe | 348 | 233 | 277 |

### Consumption of Sugar in Europe and the United States, for Three Years ending 31st May, in thousands of tons.

| | 1873. | 1872. | 1871. |
|---|---|---|---|
| Great Britain | 741 | 679 | 731 |
| France | 236 | 303 | 330 |
| Germany (Zollverein) | 257 | 216 | 201 |
| Holland | 24 | 13 | 29 |
| Six other *Entrepôts* | 106 | 107 | 90 |
| Total in Europe | 1,364 | 1,318 | 1,381 |

### Estimated Crop of Beet Root Sugar on the Continent of Europe, for the ensuing Season, compared with that of the three previous Seasons.

*(From Licht's Monthly Circular.)*

| | 1872-73.<br>Tons. | 1871-72.<br>Tons. | 1870-71.<br>Tons. | 1869-70.<br>Tons. |
|---|---|---|---|---|
| France | 395,000 | 335,000 | 289,000 | 289,000 |
| Germany (Zollverein) | 260,000 | 189,000 | 263,000 | 217,000 |
| Austro-Hungary | 205,000 | 162,000 | 182,000 | 151,000 |
| Russia and Poland | 150,000 | 90,000 | 135,000 | 133,000 |
| Belgium | 80,000 | 72,000 | 56,000 | 44,000 |
| Holland and other Countries | 35,000 | 25,000 | 17,000 | 12,000 |
| Total | 1,125,000 | 873,000 | 942,000 | 846,000 |

# SUGAR STATISTICS—GREAT BRITAIN.

To 11th May, 1873 and 1872. In Thousands of Tons, to the Nearest Thousand.

| | STOCKS. | | | | | | IMPORTS. | | | | | | DELIVERIES. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. |
| British West India | 14 | 2 | 1 | 13 | 29 | 18 | 20 | 4 | 3 | 14 | 40 | 40 | 24 | 3 | 4 | 17 | 48 | 46 |
| British East India | 13 | 3 | .. | .. | 16 | 4 | 14 | 3 | .. | .. | 17 | 7 | 9 | 3 | .. | .. | 12 | 9 |
| Mauritius ...... | 5 | 2 | 3 | 1 | 10 | 4 | 9 | 3 | 10 | 8 | 29 | 26 | 8 | 1 | 8 | 8 | 25 | 27 |
| Cuba .......... | 2 | 4 | .. | 5 | 12 | 6 | .. | 3 | 2 | 4 | 9 | 15 | 3 | .. | 2 | 10 | 15 | 18 |
| Porto Rico, &c. .. | 1 | 6 | .. | .. | 7 | 3 | .. | 8 | .. | 1 | 10 | 4 | 2 | 6 | .. | 1 | 9 | 5 |
| Manilla & Java .. | 24 | 8 | .. | 4 | 37 | 19 | 13 | 6 | 5 | 6 | 29 | 28 | 10 | 3 | 5 | 5 | 23 | 32 |
| Brazil .......... | 3 | 19 | 1 | 4 | 27 | 17 | 3 | 28 | 2 | 6 | 42 | 37 | 2 | 23 | 2 | 8 | 35 | 34 |
| Beetroot, &c. .... | 5 | 1 | .. | 3 | 9 | 8 | 13 | 8 | 6 | 16 | 42 | 52 | 14 | 9 | 7 | 25 | 55 | 58 |
| Total, 1873 .. | 67 | 45 | 5 | 30 | 147 | 79 | 72 | 63 | 28 | 55 | 218 | 209 | 72 | 48 | 28 | 75 | 222 | 229 |
| Total, 1872 .. | 31 | 23 | 4 | 20 | 68 increase | | 56 | 49 | 29 | 75 | 9 increase | | 65 | 52 | 30 | 83 | 6 decrease | |

## STATE AND PROSPECTS OF THE SUGAR MARKET.

The dulness which prevailed in the market for both raw and refined sugar at the close of April has been gradually replaced by a feeling of confidence. As the changes in the duty proposed in the Budget duly passed through Parliament and came into operation, the trade began rapidly to settle down to its new conditions. The refiners, anxious to make up for lost time and to reap the advantage of supplying the starved refined market, resumed work promptly on the 8th, some of them working extra time. For the first few days in the present month, and after the new duties had been passed, there was a decided increase in the bonded value of raw sugar, an increase due, as we stated last month, to the belief that the 8th would witness a heavy demand. But this upward tendency was more than counterbalanced by the news published on the 6th—that the Conference on the Continent had come to an end without any substantial end being gained. The effect of this announcement was depressing, and when work was resumed in the refineries, it was found that the price of raw sugar had lost all the difference in duty, and in some cases a trifle more. This continued till about the middle of the month, after which, the continued active demand for sugar turned the balance, and from that date up to the present the tendency of prices has again been upward—the bonded value being now fully up to that quoted a month ago.

No. 12 Havana afloat is worth 26s. to 26s. 6d. per cwt; fair, to good refining Cuba Muscovadoes 23s. 6d. to 24s.; middling, to good brown Bahia 19s. to 20s.

Looking to the fact that the refineries have been stopped for a month, and that therefore the country must be short of sugar, that the importations have not been excessive, and that the consumption, which has never flagged, has received a fresh impulse by the late fiscal change, it is difficult to arrive at any other conclusion than that the British sugar industry, for the moment, enjoys the conditions of a healthy prosperity, but there can be no doubt that the subsidized French competition, recommenced on the 28th, will soon modify this as heretofore.

In refined, the month closes upon a stiff market with dearer prices. The demand for loaves, crystals, and the finer kinds of pieces is keen; lower sorts are for the moment scarce and command fair value upon that account. The price of common refined lump is 36s. 6d. to 37s., a rise of 1s. 6d. upon last month's quotation, allowing for the difference in duty.

THE
SUGAR CANE.

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☞ The writers alone are responsible for their statements.

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# ON THE USE OF WET MEGASS AS FUEL.

### By Alfred Fryer.

Object of Inquiry.—The best mode of converting megass, after leaving the mill, into fuel, is a problem always interesting to planters, and one that has not yet received a satisfactory solution. The following article is offered as a slight contribution to the subject; the present high price of coal rendering economy of fuel even more important than heretofore.

Present Methods.—The modes of treatment of the megass, at present adopted, vary in their character. In many of the old colonies the crushed cane is stacked in heaps and exposed to the weather, and the long stalks of the megass are so disposed as to carry off a large portion of the rain that may fall upon the piles. The action of the sun and air from without, and the fermentation proceeding within the mass, dry the megass sufficiently to permit its use as fuel. Whether the juice be expressed by wind or water power, or by means of a steam-engine, the megass so prepared, with perhaps the occasional addition of a little wood, is usually sufficient to generate heat for the evaporation of the cane ^ and for /ju its clarification; and, where needful, for the production of steam to drive the engine, and in such cases the exhaust steam is used for heating the clarifiers. That the amount of fuel is sufficient, is not so much due to the simplicity of the process, as to the circumstance that the juice is inadequately expressed. The condition and appearance of the megass attest this. Mills yielding megass in long stalks do not, on the average, express more than 55 per cent. of juice, and many of them a still less proportion. The mechanical power needed to effect this is not great, but it increases enormously when the limits of expression by mechanical force are approached. A good mill will extract 70 per cent., but will probably require double the power needed to extract 55 per cent. If, then, the amount of megass obtained in the first case is only barely sufficient to extract and concentrate 55 per cent., it is clear that in the second case there will be no fuel to concentrate $\frac{15}{70}$, or more than one-fifth of the juice; no fuel to clarify the same, and none to generate the steam required to produce the power to express the extra 15 per cent., and the force exerted to extract this is assumed to be not less than that required to express 55 per cent. Thus, it may be seen that abundance of megass for fuel is usually suggestive of insufficient expression of the juice.

In some countries, especially in Egypt and Cuba, the megass is spread out in the sunshine and air, and turned over and treated as hay. Such megass makes the best fuel, but the costliness of the mode of treatment, where labour is scarce, constitutes an objection to the process. A more serious objection is found in the circumstance that the process of sugar making becomes practically dependent upon the weather. Rain stops megass-drying, and wet fuel stops sugar-making. To add to the troubles of the planter the juice is always lighter in wet weather, so that at the very time when the fuel should be the best it is the worst.

In order to avoid the disadvantages attendant on sun-drying, the practice has been adopted in other countries of storing the wet megass in large sheds. The juice left in the fibre is soon brought into active fermentation, and the disengagement of heat is so considerable as to drive off the greater part of the moisture, and thus, without exposure to sun or air, and without any turning or other mechanical treatment, the wet megass becomes good fuel. Ten or twelve days are required to effect this drying, so that it becomes needful to retain all the megass that is made during that period, and as a large mill will yield one hundredweight each minute, and as the crushed cane is very light, the megass shed is a very large and somewhat costly edifice. But the inflammable character of the megass house is the chief objection to its use. The extent of this may be measured by the Fire Insurance offices demanding an annual premium of six guineas per cent. The destruction of a megass house, or *loge,* not only endangers the works and the uncut canes, but also impedes the removal of the residual portion of the crop.

The various objections to the megass *loge* increase with the magnitude of the works, and have become so intolerable in the large French Central factories, that a portion of the megass is conveyed direct from the mill to the large combustion chambers of the multitubular boilers, and the intensity of the combustion is maintained by the admixture of coal. The remaining portion of the megass is reduced to ash by combustion in a furnace, constructed solely for this purpose, and no attempt is made to utilize any of the heat generated thereby. Powerful mills, and good expression of the juice, are essential to the production of megass capable of being burnt without further drying. Yet the wastefulness of this method is so great, that, notwithstanding the use of the triple effect vacuum pans, and the use of steam of high pressure, in order to save fuel, a large quantity of coal is used. The dense smoke emitted from the row of chimneys of D'Arboussier, once seen, will not be forgotten. The whole town is blackened with the soot, and the failure of the system is proclaimed by the effect of this imperfect combustion.

Proposed New Methods.—The various difficulties attendant upon the use of megass as fuel, and the importance of returning to the soil the saline constituents of the cane, have led to the recommendation, in some quarters, of the return of the megass to the land as manure, and the substitution of coal or wood for fuel. Yet, as this method involves a large amount of carting, and as in the tropics there seems, in most cases, little need to return humus or carbon to the soil, this process is a wasteful one. The salts may be restored by the return of the megass ashes to the land. This method of solving the megass problem does not promise well.

It has long been seen by the thoughtful colonial engineer that if the waste heat that passes up the chimney could be used in drying the megass as it leaves the mill, without much complication or expensive apparatus, or the expenditure of much labour, the problem would be solved. The fuel would be, as a certain puffing advertisement declares, "always good alike." The process of sugar making would not be dependent on weather, large stores of megass would be no longer necessary, and the danger of conflagration materially reduced. Among the clever schemes to dry the megass—the "Megassicator," that originated in Trinidad, must not be overlooked. One of these pieces of apparatus was taken to Cuba by Mr. Mitchell, a gentleman in whose hands it had every chance of a fair trial. It, however, proved to be a costly and cumbersome machine, and the special obstacles which interfered with its adoption need not be considered here.

Of the various schemes for drying megass which have been proposed, most have failed from want of consideration of the number of units of heat, and the amount of time needed for the work to be effected, and from forgetfulness of the great evil arising from a spoiled chimney draught.

Certain engineers, fully appreciating the difficulties of drying the megass, have turned their attention to its more effectual combustion in a wet state. They have seen that, if it be possible to burn megass fresh from the mill by means of special furnaces and artificial draughts, and at the same time not to lose materially either in speed of evaporation or in available heat, the needful additions and alterations would be gladly made; but, hitherto, they have found that, though emancipated from one series of difficulties, they have to encounter another series, and at the present time there seems little to choose between the two systems: the rocks of Scylla prove as objectionable as the whirlpool of Charybdis, so it is prudent to endeavour to avoid both—to partially dry the megass before burning, and to effect this without using the waste heat from the chimney.

Having now glanced at the various methods adopted or avoided, the subject may be examined a little more in detail. It will be proper to discover the extent of work required to be accomplished, and then consider how it may be effected. It will be also needful to ascertain the value of various kinds of fuel, and compare them with megass.

COMPARATIVE VALUE OF VARIOUS CLASSES OF FUEL.—The amount of heat needful to raise a certain weight of water, through a certain range of the thermometric scale, is termed a "unit of heat," and the number of units of heat required for the production of certain effects, and the number of units liberated by the combustion of various qualities of fuel having been ascertained, it is easy to estimate the comparative value of such descriptions of fuel, and their fitness for the work desired. The "British thermal unit" is the amount of heat required to raise one pound of water from 32° Faht. to 33° Faht. The British thermal unit will be alone used in this article.

The value of various descriptions of fuel depends directly on the number of units of heat liberated by their combustion, and inversely upon the weight of the products of combustion which, on entering the chimney, take with them that portion of the heat, usually termed waste heat.

The effective value of each combustible is obtained either by direct experiment, or by a calculation based on its chemical constitution. The experiments are conducted by the combustion of the fuel under water in such manner that the heat liberated is imparted to the water, and care is taken to avoid, or allow for, loss arising from radiation and other sources of error.

Where the value of the fuel is deduced from its chemical composition, the mode of computation here adopted is as follows:—Carbon and hydrogen, by their combustion, or rapid union with oxygen, are the main sources of heat. One atom of carbon will unite with one atom of oxygen, and form carbonic oxide ($CO$); and as the atomic weights of these elements are respectively 6 and 8, they will unite in these proportions by weight; and careful experiment has shown that one pound of carbon, burnt into carbonic oxide, will raise 4,400 lbs. of water 1° Faht. in temperature. Thus, it is said, that the thermal units of $C$, burnt into $CO$, are 4,400. But one atom of carbon will also unite with two atoms of oxygen, or 6 lbs. of carbon will unite with 16 lbs. of oxygen, and form carbonic acid ($CO_2$), and the thermal units of carbon so burnt are 14,400, or more than 3¼ times as many. The importance of the perfect combustion of the carbon is thus apparent. The heat-giving power of hydrogen is very great: one atom of this gas unites with one atom of oxygen, or one pound of hydrogen unites with 8 lbs. of oxygen, and forms 9 lbs. of water, liberating as much heat as would raise 62,000 lbs. of water 1° Faht. But combustibles that contain hydrogen usually contain oxygen also, and as the same quantity of heat is absorbed in disengaging these two gases when they are chemically combined, as is given out by their chemical union, it is needful, in the first place, to deduct from the amount of hydrogen present in any combustible as much as will be required to unite with the oxygen present, or one-eighth the weight of the oxygen, and treat the remainder only as a combustible.

Thus, one thousand parts of air dried wood yielded, on analysis:

| | |
|---|---|
| Carbon .. .. .. .. .. .. | 400 |
| Hydrogen .. .. .. .. .. .. | 48 |
| Oxygen .. .. .. .. .. .. | 328 |
| Ash, &c. .. .. .. .. .. .. | 24 |
| Hygroscopic Water .. .. .. .. | 200 |
| | 1,000 |

| | | |
|---|---|---|
| Of the Hydrogen .................... | 48 | |
| There were combined with O (328 ÷ 8) = | 41 | |
| Leaving of H. available as fuel ...... | 7 | |
| The H., 7 × 62,000 the thermal equivalent of H = | | 343,000 |
| And the Carbon 400 × 14,400................ = | | 5,760,000 |
| | | 6,194,000 |
| But the combustion of 48 parts of H produced of water .................................. | 432 | |
| And there was present in the wood, Hygroscopic water .................................. | 200 | |
| Total water .................. | 632 | |
| And the heat used in converting this into vapour 1,100° + 632 .................... = | | 695,200 |
| | | 5,498,800 |

Thus the total heat from the air dried wood is 6,194,000 per 1000 parts, or 6194 for one part. If, however, the vapour of water be not condensed in the mode of using the heat, 695 units must be deducted, leaving the available heat 5499 units.

The following are the usually received thermotic values of various combustibles :—

| Substance. | British Thermal Units. |
|---|---|
| Carbon | 14,400 |
| Hydrogen | 62,032 |
| Marsh Gas $CH_4$ | 25,500 |
| Olifiant Gas $C_2H_4$ | 21,350 |
| Ether | 16,250 |
| Alcohol | 12,920 |
| Sulphur | 4,000 |
| Coal, dry | 14,000 |

In order to proceed upon experiments on which reliance can be placed and that are consistent among themselves, a series of experiments have been specially made at the laboratory of Dr. R. Angus Smith, F.R.S., and with the following results :—

Pounds of Water heated 1°F. by the combustion of one pound of dry

| | |
|---|---|
| Wigan Cannel | 14,000 |
| Little Hulton Cannel | 13,900 |
| Lancashire Engine Coal, used by Mr. Thorp | 13,300 |
| Ditto ditto Fletcher's, used by F. B. & F. | 12,800 |
| Midland Slack, used by F. B. & F. | 12,700 |
| Charcoal | 12,000 |
| Bebbington Coal | 11,700 |
| Hucknall Coal | 11,400 |
| Boxwood Charcoal | 11,100 |
| Pitch Pine | 11,100 |
| Hard Coke, Manchester Gas Works | 9,700 |
| Soft Coke, Manchester Gas Works | 7,900 |
| Oak | 9,700 |
| Deal | 9,300 |
| Peat | 5,100 |
| Peat | 4,850 |
| Sugar | 4,750 |

Several experiments were made with megass, but the difficulty of reducing an average sample to a very fine powder led to results that were not reliable. An examination of the analysis of megass, and especially of the article at page 68, *Sugar Cane*, Vol. 1, and a comparison with the heat-giving power of cellulose and of various substances of a similar nature, lead to the conclusion that perfectly dry fresh megass contain 6100 units of heat available, the chemically formed water being discharged as vapour. The value of steam coal of fair quality, may be taken as 13,000 units, so that the value of dry megass as fuel is 47 per cent. of that of coal.

Thermotic Value of Damp Megass.—Megass, like other classes of fuel, is never absolutely dry, and even a carefully prepared sun dried sample will contain 9 or 10 per cent. of water.

The following table shows the proportions of woody fibre and moisture found in megass :—

| Quality. | Megass. | Parts by weight of Fibre. | Parts by weight of Moisture. | Per cent. of Moisture. |
|---|---|---|---|---|
| 1 | Absolutely dry ............ | 10 | 0 | 0 |
| 2 | Good sun dried ............ | 10 | 1 | 9 |
| 3 | Average dry megass ........ | 10 | 2 | 17 |
| 4 | **Fresh from most powerful mills obtaining 73 per cent.** | 10 | 10 | 50 |
| 5 | **Fresh from good steam mills expressing 66 per cent. . .** | 10 | 16 | 62 |
| 6 | **Ordinary steam mills extracting 62 per cent.** ........ | 10 | 19 | 66 |
| 7 | **Average windmills yielding** 55 per cent............ | 10 | 25 | 72 |

In the above table it is assumed, that taking the average of plant canes and ratoons, juicy and dry, the woody fibre constitutes 13 per cent. of the weight of the canes.

Let it be supposed for the present, that megass of each of the seven foregoing types can be completely burnt. It is desired to ascertain the number of available units of heat from the combustion of one pound of woody fibre, and also what is the maximum temperature of the products of combustion. Thus, in example No. 1, one pound of megass alone will be taken; in example No. 4, two pounds will be taken, which will be composed of one pound of fibre and one pound of moisture.

*Table showing the amount of heat generated by one pound of megass fibre, both anhydrous and associated with varying proportions of moisture; the maximum temperature of the products of combustion, and the number of feet of gases and vapour passing up the chimney at 600° Faht.*

| 1<br>No. of Experiment. | 2<br>Quality of Megass. | 3<br>Moisture. | 4<br>Heat from one pound dry combustible. | 5<br>Heat from sugar in associated juice. | 6<br>Total Heat. | 7<br>Loss by conversion of moisture into vapour. | 8<br>Lost in Chimney. | 9<br>Heat available. | 10<br>Maximum Temperature of products of combustion. | 11<br>Volume of Gases and Vapour at 600° in Chimney. | 12<br>Volume of Gases and Vapours at 600°, after combustion of sufficient fuel to liberate 4503 available units. | 13<br>Ditto ditto 4342 available units. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Percent | Units. | Units. | Units. | Units. | Units. | Units. | Deg. F. | C. Feet. | C. Feet. | C. Feet. |
| 1 | Anhydrous............ | 0 | 6100 | 0 | 6100 | 0 | 1597 | 4503 | 1910 | 288 | 288 | 278 |
| 2 | Good sun dried ........ | 9 | 6100 | 50 | 6150 | 101 | 1627 | 4422 | 1840 | 293 | 298 | 288 |
| 3 | Average dry .......... | 17 | 6100 | 100 | 6200 | 202 | 1656 | 4342 | 1786 | 299 | 310 | 299 |
| 4 | From mill extracting 73 per cent. | 50 | 6100 | 500 | 6600 | 1010 | 1894 | 3696 | 1380 | 343 | 417 | 403 |
| 5 | ,, 66 per cent... | 62 | 6100 | 800 | 6900 | 1616 | 2072 | 3212 | 1160 | 376 | 528 | 509 |
| 6 | ,, 62 per cent... | 66 | 6100 | 950 | 7050 | 1919 | 2161 | 2970 | 1068 | 393 | 597 | 574 |
| 7 | ,, 55 per cent... | 72 | 6100 | 1250 | 7350 | 2524 | 2339 | 2487 | 910 | 426 | 770 | 743 |
| 8 | Wigan Cannel ........ | .. | 14000 | .. | 14000 | .. | 3159 | 10841 | 2320 | 655 | 272 | 262 |
| 9 | Average Steam Coal.... | .. | 13000 | .. | 13000 | .. | 3159 | 9841 | 2150 | 651 | 298 | 288 |

It is assumed that the products of combustion enter the chimney at a temperature of 600° Faht. Also that each pound of dry megass requires in practice 9·7 lbs., or 130 cubic feet of air, for its combustion. That if the megass be burnt directly from the mill, the sugar present in the moisture will act as fuel; but as the total residual moisture is less rich in sugar than is cane juice, and as decomposition sets in from the very moment that the cell which contains the juice is ruptured, it is assumed that ten per cent. of the moisture is sugar with a heat equivalent of 5000 units. That the temperature of the air and fuel are 80° Faht. That the specific heat of products of combustion by weight is ·27. That the specific heat of vapour of water by weight is ·85.

In the foregoing table the loss of heat caused by the conversion into steam of the water formed by the combustion of the hydrogen has been deducted, and column 4 gives the units of heat diminished to this extent. This mode of computation is necessary, as the waste heat is discharged into the chimney at a temperature so high as to preclude the condensation of any vapour of water.

The maximum temperature given for the products of combustion of coal is lower than that given in some treatises. This arises from the heat being diffused not only among the air *chemically* necessary to furnish the oxygen from the complete combustion of the megass, but also the surplus which is actually required in practice. The figures here presented may be accepted as nearly correct, and are strictly comparable with those relating to the megass.

Effect of Climate on Combustion.—The air which is needed to supply oxygen to burning fuel, tends at the same time to diminish the total amount of heat generated in proportion to the coldness of the air. Thus it might be expected that the hotter the air, or the hotter the day, the more heat would be given out by the burning fuel, and the more fiercely the fire would glow. If, for instance, a pound of dry megass gives 4503 units of available heat, with the thermometer at 80° Faht., there will be a gain of heat over the amount that would be available with the thermometer at 30 F. Ten pounds of air with a specific heat of ·27° will enter the furnace at a lower temperature, in the latter instance, than the former by 50°Faht., and this equals a loss in the latter case of 135 units. Yet, it is a matter of observation, that furnaces burn better in cold weather than hot. It is even popularly believed that sunshine will extinguish a parlour fire, and an unusual brightness of the fire, is an almost certain indication of frost. The difference in the force of the draught is not sufficient to account for this circumstance.

The phenomenon has been attempted to be explained by the hypothesis that warm air contains much moisture, and that this vapour of water robs the fire of much heat. It may be well to deduce the maximum loss of heat due to this cause. Compare the combustion of a pound of dry megass, with air at 80°Faht. and charged with moisture to within 20 per cent. of saturation, with another pound of dry megass burnt with air at 30°, also charged with vapour of water to within 20 per cent. of saturation; 130 feet of air being used with each pound of megass. A cubic foot of saturated air at 80°Faht. contains 11 grains of vapour, and at 30°Faht. only 2 grains.

In the 130 feet of air at 80°Faht. there are 936 grains, or ·136 lb. of vapour more than in the air at 30°Faht. The maximum temperature of the products of combustion with dry air is

$$10{\cdot}2 \times {\cdot}27 + {\cdot}5 \times {\cdot}85 = 3{\cdot}19 \qquad \frac{6100}{3{\cdot}19} = 1910^\circ$$

and with air containing 936 grains of additional vapour it is

$$\frac{6100}{3{\cdot}19 + {\cdot}136 \times {\cdot}85} = 1845^\circ.$$

Thus in the extreme instances given, the moisture in the air would reduce the maximum temperature of the products of combustion by about ~~180~~ 65° Faht. In estimating the practical value of any combustion two considerations are important, first, the total number of units of heat available; second, the temperature of the products of combustion. It has been shown to what extent the moisture in the hot moist air has reduced the temperature of the products of combustion, it remains to be shown to what extent it reduces the number of available units of heat.

When the air is hot it is supplied to the furnace at 80°, and is discharged into the chimney at 600°. The vapour is of course admitted and discharged at like temperatures. The loss in available heat due to the moisture at 80° is

$$\frac{11 \times \cdot 8 \times \cdot 85 \times 130 \times (600 - 80 = 520)}{7000} = 72 \text{ units.}$$

And the loss, due to the moisture alone, at 30° is

$$\frac{2 \times \cdot 8 \times \cdot 85 \times 130 \times (600 - 30 = 570)}{7000} = 14 \text{ units.}$$

Thus the loss of available heat from the presence of vapour is greater at the higher temperature than at the lower, by 58 units.

But there is an advantage arising from the use of air at 80°, in consequence of its entering the furnace at a higher temperature. To supply the furnace 9·7 lbs. of air are furnished to consume each pound of megass. The specific heat of air is ·27.

$$9 \cdot 7 \times \cdot 27 \times 50 = 131 \text{ units.}$$

| | Units. |
|---|---|
| Thus at 80° there is as compared with 30° a gain, due to temperature, of...................... | 131 |
| And a loss, due to vapour, of .................. | 58 |
| Leaving a clear balance in favour of 80° of.. | 73 |

It would thus appear that the effect of warm moist air is to diminish the intensity of a fire—but to increase the quantity of it. As the intensity of the fire affects the speed of combustion, the general results would be expressed thus: Hot warm air diminishes the speed of work, but increases the amount of work obtained from the combustion of a given quantity of fuel. Still it must not be overlooked that the effects here given are but small in amount. In the extreme instances selected, the intensity of the fire would only be augmented by three per cent., and the economy of fuel would not amount to two per cent.

It may be well to endeavour to attack the problem from some other side as the figures arrived at do not appear sufficient to account for the marked loss of intensity in fires supplied with warm moist air.

Dr. R. Angus Smith has pointed out that when a current of air mingled with steam is impelled into a furnace which emits dense smoke, that the smoke at once disappears. He suggests the following as an explanation. The vapour mingled with the air is decomposed into its constituents by contact with the heated carbon; the oxygen of the water unites with the carbon, forming carbonic oxide or carbonic acid, and the hydrogen passes off to be burnt a little further away from the fuel by uniting with a sufficient supply of oxygen for the purpose. Dr. Smith writes:—

"It may be asked why the vapour of water does not decompose in the presence of carbon, red hot as the carbon is, we suppose, before it issues in a black condition. There is a mode of consuming smoke which consists in simply blowing into the furnace a jet of steam. The effect is instantaneous and remarkable. A clear flame is produced in a few seconds. This circumstance has probably induced many persons to attempt to burn steam; it certainly has the appearance of burning, but these people do not consider that water is already burnt; it is a product of combustion, chemically speaking it is an oxide, and can burn as little as ashes can burn. The cause of the appearance is easily imagined. The water is decomposed by the heated carbon, whilst hydrogen and carbonic oxide, both combustible gases, are formed. These again come in contact with air, and then burn readily and clearly. The consequence is that no carbon appears in the smoke; it is burnt by halves, by two processes instead of one; and the flame extends itself forward, as a little time is required for these operations."—*Government Inspector's Fifth Alkali Works' Report.*

Will it be possible to extract from this theory, a reason for the fire being less bright when supplied by moist air? The mode in which water is introduced into a furnace is all important in considering this part of the subject. If wet fuel be placed upon the fire, the radiated heat and the heated gases passing upwards from the burning mass into the wet fuel raise its temperature and drive off the water in the form of vapour. When the heat is sufficient to raise the temperature of the fuel to 212°, steam is freely given off and so continues until the lowest layer of fresh fuel has parted with its water, when its temperature rises and its condition is changed, and it no longer absorbs heat, but produces it as it burns away. The water in the fuel does not reach the fire at all. Not so the vapour in the air. No oxygen can come in contact with the heated carbon without bringing its share of vapour along with it, and whilst a portion of the heated carbon seizes on the oxygen of the air another portion is employed in taking oxygen from the vapour and thus leaving the hydrogen free. In fact the burning carbon would supply itself entirely with oxygen from water vapour but for the circumstance that the same amount of heat would be absorbed by separating water into its elements that is given out by their union, and heat would thus cease to be evolved.

Water is composed of one-ninth part by weight of hydrogen, and as the thermotic value of this gas is 62,000 units it follows that the heat evolved by the union of sufficient oxygen and hydrogen to produce a pound of water is $62{,}000 \div 9 = 6888$ units; and the amonnt of heat lost in the decomposition of a pound of water is also 6888 units. Now consider what will happen when a pound of dry megass is burnt with 130 feet of moist air at 80° as before; or rather contrast this combustion with that of another pound furnished with air at 30°. In the former case the air contains more moisture than in the latter by

$$130 \times 11 \times \cdot 8 - (130 \times 2 \times \cdot 8) = 936 \text{ grains of vapour,}$$

which being resolved into its constituent gases, absorb—

$$\frac{936 \div 9 \times 62{,}000}{7{,}000} = 921 \text{ units.}$$

But in this separation, eight-ninths of the 936 grains are oxygen. This oxygen during combustion unites with the carbon, either in the proportion of 8 to 6, forming carbonic oxide, and yielding of heat—

$$\frac{936 \times \frac{8}{9} \times \frac{6}{8} \times 4{,}400}{7{,}000} = 392 \text{ units,}$$

or in the proportion of 8 to 12, forming carbonic acid, and yielding of heat—

$$\frac{936 \times \frac{8}{9} \times \frac{12}{8} \times 14{,}400}{7{,}000} = 256 \text{ units.}$$

Thus the effect of the vapour brought into contact with the burning fuel, is to remove not fewer than 921 units of heat, and to restore at the same time either 392 units or 256 units, dependent upon whether carbonic oxide or carbonic acid be formed. It would seem that a cause has now been found for an abstraction of heat in the centre of the fire, of 529 or 665 units. But it must not be forgotten that the carbon would have been perfectly consumed if the water vapour had been absent, and the oxygen arising from the decomposition of the vapour only replaces oxygen from the air, and thus it appears that the real abstraction of heat is not less than 921 units. With the transference of such a quantity of heat from the heart of the fire by the moisture in the air, a reason is discovered for sluggish fires in hot weather, and for brilliant fires when supplied with cold and consequently dry air.

It must not be overlooked that this is only a change of the production of heat from one part of the fire to another, for the hydrogen eventually takes fire and yields up its 921 units of heat, after having allied itself with that very oxygen which was prevented from uniting with the carbon by being supplanted by the oxygen derived from the water.

If the theory of Dr. R. Angus Smith be correct and the application of it here made be sound, it may be well to note the extent of the reduction of heat in the centre of the fire due to each grain of vapour. The rule is an easy one to remember. *Each grain of vapour decomposed by the burning fuel, reduces the heat liberated at the centre of the fire by one unit.*

(*To be continued.*)

In the German Chemical Society, held at Berlin, May 12th, C. Scheibler referred to a gum $C_{12}H_{22}O_{11}$ (isomeric with arabine), which he found in beetroot, and which is identical with metapectic acid. It occurs in two modifications, turning the plane of polarization to the right or to the left. The latter is transformed by Sulphuric Acid into "arabine sugar," identical with the sugar he obtained by the same process from arabine. Both crystallize in identical rhombic prisms, turn the plane of polarization to the right ($\alpha = + 116^\circ$), reduce solutions of copper, and do not ferment.

# ON IRRIGATION.

(*Continued from page* 294.)

Before proceeding to the consideration of the amount of water necessary for proper irrigation, it will be useful to pass in review the chief offices fulfilled by the water which the soil receives, and to examine into the extent of the already existing supply. We shall perhaps come nearest to our purpose by endeavouring to account for the disposal of the rainfall. In the first place, a large portion of the rain passes off the land as rivers. It has been estimated that the Rhine bears away as much as four-fifths of the rain falling on its watershed, and the river Thames about one-third. According to Dalton's experiments, 25 per cent. of the rain passes through the soil as drainage. The latest and most careful experiments however are those of Messrs. Lawes and Gilbert, who found that during the last four months of 1870, with a rainfall of 10½ inches, as much as 50 per cent. passed through 20 inches of the soil, 40 per cent. passed 40 inches, whilst about 20 per cent. reached as far as 60 inches from the surface. The question now suggests itself—How much of this is available for the plant? To form some idea of this, we must again have recourse to Messrs. Lawes and Gilbert's experiments. They find that the soil, so long as it is unmanured, is altered by the crops to a depth of only 18 inches, but when manured with ammonia compounds, to twice that depth, or 36 inches; whilst, when nitrate of soda is applied, the soil is influenced through 54 inches, or 4½ feet deep. The cause of the remarkable effect of the use of nitrates is apparently due to their superior power of diffusion; the roots of plants following their food and thus attaining three times the depth they would have reached in unmanured soil. In the case of two manured plots, examined by the same experimenters and compared with unmanured plots, it was found that for the first 9 inches in depth the former contained the most moisture, whilst for distances below that the latter had the advantage.

Their experiments, extending over a long period, justify them in coming to this most interesting and important conclusion, that continued manuring increases the power of the soil to retain moisture. During the drought of 1870 it was found that grass suffered most, barley considerably, and wheat least, to which however grass manured with nitrate of soda, and barley with farmyard manure were notable exceptions.

From these facts then, it appears that unmanured soil would have 50 per cent. of the rainfall drained away, whilst soil manured with nitrates might have only 20 per cent. drained out of reach of the roots, which are the chief water absorbents.

Again, plants exhale moisture from their leaves and other green parts, the amount exhaled increasing with the activity of growth. Messrs. Lawes and Gilbert have found by experiment that, during the growth and ripening of graminaceous and leguminous crops, for every pound of dry substance produced, from 250 to 300 lbs. of water have been exhaled; therefore a crop of wheat or grass which yields say 2½ tons of dry matter per acre will, by the end of July in the first case, and by the end of June in the second, have evaporated 750 tons of water per acre, which is equivalent to about 7½ inches of rain over that space.

A large portion of the rainfall then is exhaled through the plant into the air, another larger portion passes through the soil and is carried off in the rivers, whilst the remainder remains in the soil or is decomposed and made into plant substance, or enters the plant as water, or finally, evaporates into the air from the surface of the soil.

It is most probable that part of the water exhaled or evaporated is received again as dew or condensed on the soil. There is little doubt too that a considerable quantity is often absorbed from the atmosphere, which always contains moisture even when there are no signs of rain.

The chief benefits of irrigation may result from the employment of pure water, independently of the salts and other matters it may hold in solution or suspension. When the soil is kept sufficiently moist, the water dissolves and brings much of the plant food already in the soil within reach of the roots, and the changes of temperature to which the soil is ever exposed helps to keep this water in constant motion, and to distribute more completely the manure as food. It also protects against the extremes of heat and cold: here as elsewhere water approximates the extremes of temperature. Besides taking longer to heat up than the earth, by evaporation it converts heat into cold and thus keeps the soil cool and refreshed in hot weather. In cold weather, on the other hand, the water by taking longer to cool preserves a temperature above the dry soil, and when the temperature gets so low as freezing the ice formed keeps the under-soil warm. Hence the value of irrigating in winter as a means of keeping the soil above freezing. If water be run over a field of grass on the morning after a white frost all injurious effects will be prevented.

Again, it is natural to suppose that plants as well as animals should require the removal of their effete matter for life at all, much more for healthy life. This is effected by water drainage, and is probably one of the great values of a plentiful supply of good water, for if the effete matter is allowed to remain about the plants disease is the natural result. The water freely applied washes the leaves and stems, but more particularly the roots, from which the impure matter is chiefly discharged, and carries it away in the drainage. In addition to that, the water washes out the spent air and gases lodging in the soil, causing them to be replaced by fresh air. By dividing the soil and making it more porous, the water enables it to be more thoroughly aerated, besides itself carrying air with it in solution. Another important office performed by a good supply of moisture in the soil is the assistance it gives the air in its chemical action, by which the soil is disintegrated and the mineral and organic constituents decomposed and prepared for the use of the plant.

The same water should not be allowed to do too much work—to pass over too great an extent of land—for after flowing over a certain surface it appears to deteriorate, not from a loss in fertilizing properties, but probably from having absorbed as much effete matter from the vegetation as it is adapted to bear away safely; it has, indeed, performed its work as a purifier.

In irrigating then, it is not sufficient to supply just enough water to keep the soil moist, but it must be made to wash the soil, and the wash water carried away in the surplus. The question now arises, How much water is sufficient for this purpose? We must look for an answer to this question not so much as yet to theoretical considerations, as to the amount found to answer practically in successful irrigation.

In former times, and even in many places at the present day, the water appears to have been run on to the land without any special regard to quantity, and we find no more definite instructions given than such as Pliny gives when he writes, "meadows ought to be watered immediately after the equinox, and the water restrained whenever the grass shoots up into the stalk." But where water is scarce and has to be conveyed from distances at great expense, it is of importance that the minimum amount requisite for effectual irrigation be determined as accurately as possible. This may be done, and indeed has been estimated, subject of course to modification according to the rainfall, climate, character of the ground and the produce.

It will be of interest to examine into the amount judged to be necessary by the directors of the latest Italian scheme, that of Lake Maggiore, to which we have already referred, and then to compare the allowance here given with that supplied to irrigated tracts in other countries.

From Table I., it will be seen that the mean of the supplies allowed by the three authorities given is 15,000 cubic feet per acre for meadow, and 18,000 cubic feet per acre for arable land, at each irrigation, or, given as continuous water the amount allowed is

·01346 cubic feet per second per acre for sandy soil,
and ·00924 „ „ „ clayey soil,

otherwise—1 cubic foot per second is made to irrigate 120 acres, the waterings being applied monthly.

### Table I.*

*Volume of Water in cubic feet necessary per acre for Irrigation.*

| | Absorbed. | | Utilized. | | Expended. | |
|---|---|---|---|---|---|---|
| | Meadow | Arable. | Meadow | Arable. | Meadow | Arable. |
| De Regis........ | 5,885 | 8,476 | 8,665 | 9,323 | 14,550 | 17,799 |
| Cantoni ........ | 5,885 | 8,476 | 8,411 | 8,454 | 14,296 | 16,930 |
| Committee of Engineers... | 5,885 | 8,476 | 10,404 | 11,314 | 16,288 | 19,790 |
| Totals...... | .... | .... | 27,480 | 29,091 | 45,134 | 54,519 |
| Mean ...... | 5,885 | 8,476 | 9,160 | 9,697 | 15,045 | 18,173 |

### Table II.*

*Area in acres that can be Irrigated by one cubic foot per second.*

| | Meadow Land. | | Arable Land. | |
|---|---|---|---|---|
| | Sandy. | Clayey. | Sandy. | Clayey. |
| | Watered once in 7 days. | Watered once in 10 days. | Watered once in 14 days. | Watered once in 20 days. |
| De Regis .......... | 41·46 | 59·22 | 67·78 | 96·83 |
| Cantoni ............ | 42·19 | 60·28 | 71·26 | 101·80 |
| Committee of Engineers | 37·07 | 52·91 | 60·95 | 98·86 |
| Total........ | 120·72 | 172·41 | 199·99 | 297·49 |
| Mean........ | 40·23 | 57·47 | 66·66 | 99·16 |

To compare this with other fields of irrigation, it will be sufficient to consider the following, for which the water duty of one cubic foot is given.

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* *Engineering*, vol. xx. p. 71.

A cubic foot of water per second is made to irrigate:—

| | |
|---|---|
| In Northern India | 250 acres. |
| Western Jumna Canal (1863) | 280 ,, |
| Eastern ,, (1864) | 220 ,, |
| Ganges Canal (1864) | 140 ,, |
| Granada—Spain | 244 ,, |
| Gandia—a typical ancient Spanish canal | 88 ,, |
| Piedmont and Lombardy— | |
| Former works, from | 60 ,, |
| to | 110 ,, |
| The latest scheme | 120 ,, |

Irrigation has existed in Italy since the most remote antiquity, and even the present system dates from the last half of the 14th century. It is the most notable feature, indeed, of the agriculture of Lombardy and Piedmont, and so laboriously have they applied themselves to the cultivation of the ground, that it is calculated only one-fifth of their land is sterile. Although the Italians are worthy of all praise in showing such an example of intelligent industry, and their system deserving of attention, still, however well ordered it may be, their irrigation is not carried on so economically as it might be. They have had too much water at their disposal, and have been ever too lavish of it. A glance at the figures above will show that both in Spain and in India, where the climate is very much warmer and the rainfall very much less, the same amount of water is made to do twice the work. Not only is too much water run on at each watering, but the waterings are too frequent, ranging from once a week for sandy meadow land, to once in three weeks for clayey arable soil.

*(To be continued.)*

The following short note may be of interest to our readers:—Burton in his "Highlands of the Brazil," speaks of a Mutámba, or Motámba tree *(Guaxuma ulmifolia)* which bears an emollient gelatino-saccharine fruit, *and whose gum refines sugar.*

# SOME RESEARCHES ON ANIMAL CHARCOAL IN ITS RELATION TO SUGAR REFINING.*

### By Jas. T. Armstrong.

The different methods for carbonizing charcoal have been so often and well dealt with of late, that it would be presumptive on our part to try and repeat the process again in its fulness, suffice it to say, the bones, after being calcined, are crushed to coarse powder between iron rollers, to sizes the refiner may order, some preferring finer charcoal than others. The quality of the charcoal thus obtained depends upon the skill employed in its manufacture and the care shown in selecting the bones.

The following is a selection from some samples of new charcoal French, English, and French and English mixed that we have analyzed. The samples are those of commerce.

| New Charcoal. | | | | | |
|---|---|---|---|---|---|
| Carbon ............ | 8·40 | 8·15 | 10·40 | 9·20 | 7·99 |
| Phosphates of Lime and Magnesia .. | 81·44 | 81·67 | 79·05 | 78·40 | 81·21 |
| Carbonate of Lime .. | 8·99 | 9·13 | 8·85 | 10·32 | 9·67 |
| Sulphate of Lime .... | ·42 | ·23 | ·32 | ·59 | ·30 |
| Oxide of Iron ...... | ·11 | ·14 | ·28 | ·34 | ·12 |
| Silicic Acid and Sand.. | ·30 | ·35 | ·70 | ·85 | ·35 |
| Chloride of Sodium .. | ·34 | ·33 | ·40 | ·30 | ·36 |
| | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 |

The water in new charcoal of commerce varies from 6 to 15 per cent. The absorbent power we have found from 59 to 92·6; and the quantity occupied by a cubic foot of unshaken charcoal is from 46 to 49 lbs., whilst that of shaken charcoal is from 49 to 52 lbs. We see from this that it therefore requires some experience before those samples which are the best for the sugar refiner's use can be satisfactorily told.

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* The substance of a paper read before the Chemists' Association, Royal Institution, Liverpool.

New charcoal always contains more or less chloride of sodium, ammonia, and sulphide of calcium, and if these substances are not got rid of to a great extent, the results obtained by passing sugar over charcoal containing them, are not so good as they might be, in fact, in many cases the refiner will be greatly the loser.

The chloride of sodium may be got rid of by washing the charcoal thoroughly in boiling water, by which process some of the ammonia and sulphide of calcium are removed, but more than this is necessary, the charcoal must be burned before being used for decolorizing sugar liquor, so as to make its results as perfect as possible, washing and burning it once is not sufficient, but the refiner will find that by repeating this burning and washing three times at least, the results obtained will be greatly in his favour. The charcoal should not be burned as charcoal in use would be, but only partially, and in doing this great care should be employed.

The charcoal having being thoroughly washed and burned, we come to a question upon which there has been much controversy, viz.:—At what heat should the charcoal be put into the char cisterns? We have given this subject considerable attention. Some say the temperature is of small importance, others that it should be quite cold, whilst some affirm that no harm will be done if the charcoal is not hotter than the sugar liquor run upon it. We have seen sugar liquor quite discolored by the heat of the charcoal. My own opinion on this difficult question is, whatever may be done afterwards, cool the charcoal as much as possible after it has passed through the kilns or retorts. Careful observation will soon show which of the three methods is the most satisfactory.

It is an almost universally recognized fact, that the decolorizing power of charcoal is improved by being allowed to cool thoroughly previous to use. Many reasons have been assigned for this, but the following is new, and, although at present we are not in a position to prove this, yet, from experiments now making on the subject, it seems to be a very likely one, viz :—that the charcoal in the process of cooling *absorbs nitrogen from the atmosphere.* Charcoal becomes useless in proportion as it loses its nitrogen. We find that new charcoal on an average contains about 1½ per cent. of nitrogen, whilst in old charcoal this amount is reduced to ¼ per cent. We are only sorry that from deficiency of facts we are prevented from saying more on this important subject.

In examining the sweet washings from new charcoal, these have been invariably found to contain much sulphide of calcium and hydric sulphide, and when these results were compared with others obtained from the washings from old charcoal, it was found that a strong action must have taken place between the carbon of the charcoal and the sulphide of calcium present in the sugar solution. The damage, if any, which was done to the charcoal by this cause, and it is probable that there was a slight amount, would be greatly counteracted by being thoroughly washed and burned. This damage would increase in proportion to the quantity of lime used in the sugar solution or naturally present therein.

The chief impurities absorbed by the charcoal would be caramel, sulphate of lime, oxide of iron, silica, salts and limes of various sorts, &c.

There are so many forms of kilns and retorts for reburning charcoal, that to treat of their individual advantages and disadvantages would occupy too much of the space of this magazine. The chief objection to kilns is, that the gases contained in the wet charcoal, and which are very injurious to it, are not allowed free escape. The charcoal should be partially dried before being put into the pipes, this is to a great extent very seldom attended to, as most charcoal is put into the kilns containing at the least 24 per cent. of water. To pack the charcoal away in this manner, with no free outlet for the vapour and volatile gases driven off by the heat, must seem to most very erroneous. There are many disadvantages connected with the use of retorts, such as the larger portions of charcoal being over burnt on the outside only, as on breaking the particles the inside has been found quite perfect. Another objection is the great difficulty of getting the mass of charcoal burnt equally, this point admits of little doubt, as experiments have been made for the purpose of testing this, the samples of charcoal under examination having been sifted through different mesh sieves, and analyzed separately, the results obtained showing that the larger portions of charcoal are burnt less equally than the smaller portions. Samples of burnt charcoal, however, have been examined which give very excellent results, but a well constructed kiln has always been found far preferable.

The following will give a very good idea of the manner in which the pores of charcoal used in a refinery become smaller, and therefore unable to perform the necessary work so well as those in new charcoal, or charcoal which has only been a short time in use. The absorbent power of a sample of new charcoal before use in a sugar refinery was found to be 88·6 per cent., and the same charcoal as it at present stands (although not very old) is 53·3 per cent., showing that its pores are now filled up with foreign matter. It will therefore be seen that the surface power of the charcoal, if nothing else, has so decreased that a greater quantity is necessary to perform the same amount of work—this simply means a larger stock, more loss in weight of sugar, in fact, an increased cost in every direction, besides rendering it impossible to obtain as good results as with the best charcoal. But other causes render it useless, or almost so, unless it is properly looked after: the chief cause of vitiation is the increase of carbon daily taking place, this will be instantly seen by a comparison of the analysis of a sample of old and new charcoal. The cause of this is due in most refineries to the organic matter, which, being imperfectly washed out previous to the charcoal being passed to the kilns, is left and burnt into the charcoal. It is a bad thing also to have the carbon at too low a heat, this is caused chiefly by the air being allowed to surround the charcoal before it has been thoroughly cooled. Some samples of charcoal burnt in retorts have been found very deficient in carbon through this cause. We have no doubt that the carbon and absorbent power are the chief considerations in a sample both of new and old charcoal, and if these are at all deficient, the charcoal will not have the necessary power for the purposes of sugar refining, no matter if the other component parts be all that could be wished.

A great drawback to charcoal at any time is the increased amount of iron and lime present: with the first all refiners have, at times, some little difficulty, but with careful attention it can easily be remedied; the second—lime—few refiners in Great Britain have any occasion to look after, although in English charcoal it is sometimes present to the extent of 1·64 per cent. of carbonate of lime and 1·35 per cent. of sulphate of lime. The carbonate of lime is often of great consideration in a sample of new charcoal, if only on account of its always lessening very considerably the formation of acids usually formed in the washings. The increase of carbonate of lime is also of great importance, for it means the filling up of the pores of the charcoal and this, as we have stated, is one of the chief things to be avoided. We once examined a sample of char over which a quantity of beet sugar had passed that had increased so much in carbonate of lime that it was a matter of surprise how such a thing could have remained so long without detection.

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# NEW METHOD FOR THE DIRECT DETERMINATION OF THE AMOUNT OF REFINED SUGAR IN RAW SUGAR.

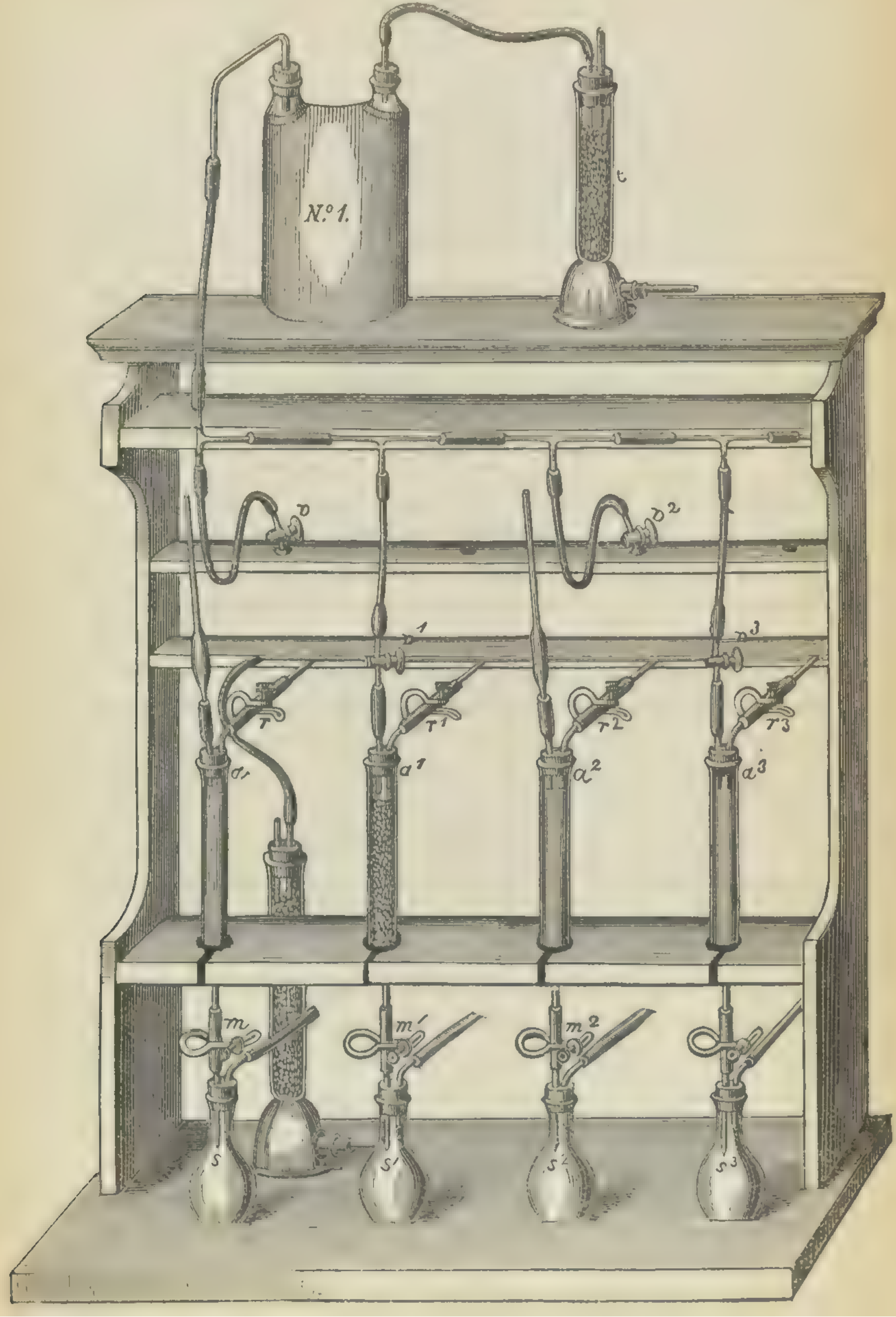
By Dr. C. Scheibler.

*(Translated from the Journal des Fabricants de Sucre. By H. C. Humphreys.)*

(Continued from page 327.)

Fig. 6 represents an apparatus by which four analyses may be carried on simultaneously, it is naturally susceptible of being enlarged, according to the number of filter tubes at disposal. These tubes rest in openings made for this purpose in a board. In

Fig, 6.



every other respect the disposition is similar to that in Fig. 3, with the exception of a doubly tubulated jar placed above the apparatus. This jar holds the acetic solution No. 1, which may be directed upon the sugar, by means of a pipe having a common communication to all the filter tubes, the communication being interrupted at pleasure, by the glass cocks $p$, $p^1$, $p^2$, $p^3$. So soon as the solution No. I. is no longer in use, the ends of the glass stop-cocks are placed in holes shown in the figure. With regard to the solutions II. and III., and the absolute alcohol, they are used as in the former case, by means of pipettes. The upper extremities of the filter tubes communicate by means of a rubber joint, furnished with compressors $r$, $r^1$, $r^2$, $r^3$, shutting off the communication when necessary, with a narrow lead pipe, which is attached to a chloride of calcium drying apparatus, so that dried air may enter the filter tubes. If now we wish to add the acetic solution No. I. the ends of the glass cocks are inserted in the rubber stopper, and the liquor is allowed to flow until the sugar is completely covered. At the same time the compressor at $r$ is shut, and $m$ is opened. If now the communication at $a$ is perfectly closed, the solution cannot escape through $m$, save, perhaps, a few drops at the beginning. By opening gently and with precaution the glass cock, the solution is made to trickle upon the sugar drop by drop, more or less rapidly, whilst the washings charged with molasses flow out below. The washing, once regulated, goes by itself; there is no longer any need of watching save one thing, that the liquid drops very slowly (1 drop every five or six seconds), in order that it shall have time to dissolve the molasses, and that there may be no useless waste of a large quantity of the solution. The remainder of the operation is conducted as above. Fig. 5 shows, besides, a water bath in which several samples may be dried simultaneously.

The sugars purified after this process possess, as the table of analytical results further on will show, a remarkable degree of purity. They are usually of a brilliant whiteness, and the yellow tint is only evident where secondary products of low grades are used. The crystals of sugar thus obtained represent in weight the

ABSOLUTE quantity of crystalline sugar in the raw sugars analyzed; that which materially proves this is the fact that the crystals, far from having the planes dull and corroded, show facets sufficiently polished and smooth to be capable of measurement by the goniometer. The sugars thus purified are not always of a complete purity, and their weight cannot serve for the determination of the real per cent. value. They contain naturally all impurities, such as grains of sand, &c., as well as several tenths of per cent. of ash and foreign substances. But they hold—and this is the essential thing—the *totality* of sugar really crystallized, and if the small quantity of extractive matter or of organic substances, colouring principles for the most part, which can be found adhering to the crystals of sugar, are not eliminated, it is from the fact that they are insoluble in the acid alcoholic solution of sugar; as, for example, the sulphate of lime; they appear like grains of sand insoluble along with the sugar, otherwise pure. However, it is an established fact that, in the purified products resulting from these analyses, there is found all the sugar really crystallized. It is sufficient to submit the residue to a polarimetric examination to establish its degree of purity, and to thus obtain all the necessary data for the valuation of the sample. An example will explain.

Suppose we have 20 grms. of raw sugar, analyzing by the polariscope 96·3 per cent., which is to be purified. There is obtained as dried purified residue 18·67 grms. This residue will then consist according to the proportion of

$$20 : 18{\cdot}67 = 100 : X$$

$$X = 93{\cdot}35 \text{ per cent.}$$

Let us take from this 18·67 grms. 13·024 grms., which is made into a solution of 50 c.c. and then polarized. This gives 99·3 per cent. of sugar. The value will be:—

$$\frac{93{\cdot}35 \times 99{\cdot}3}{100} = 92{\cdot}7 \text{ per cent.}$$

The raw sugar gave 96·3 per cent. of sugar; there is, consequently, 96·3—92·7 = 3·6 per cent. of sugar in the form of molasses. Let us pass, now, to a review of the numerous analyses which I have made as a support to my thesis under the most varied conditions—analyses remarkable for the striking precision of their results. In order always to show a new application of the process by examples of a particular interest, I endeavoured as much as possible to direct my researches upon all the types of commercial sugar, and I have chosen for this purpose the collection of types used by German refiners, which are in possession of M. F. O. Liebb, at Magdebourg. The results obtained from the analyses of the sixteen types of sugar, whose classification depends less on the degree of coloration than upon the polarimetric value, are embraced in the accompanying table—on next page—as follows:—

1. The horizontal series A shows the results obtained by the chemical analysis of the types in per cent. of water, ash,* organic matter, and sugar.

2. The horizontal series B indicates, from duplicate analyses I. and II., the per cent. of sugar dried and purified by the process above described, besides the arithmetical means to be used in subsequent calculations.

3. The horizontal series C shows the coloration and the analytical results of the dried and purified residues in ash, organic matter, and sugar, calculated at 100. These three series of numbers represent, consequently, values determined by experiment; those which follow D, E, F, G, and H, on the contrary, represent values deduced from calculations.

4. The series D represents the percentage yield, numbers for which I will propose the name "raffinations werthe," or refining value of the sample. These values represent the chemically pure sugar which can be extracted from 100 parts of raw sugar, obtained by multiplying the averages, figured in series B, by the quantity of sugar obtained by polarimetrical analysis, to be found under series C, and by dividing the product by 100.

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* The estimate of ash is made according to my method with sulphuric acid. See *Zeitschrift*, vol. xvii., p. 358.

## RESULTS OF EXPERIMENTS MADE ON THE GERMAN SUGAR STANDARDS.

| | | Number of the types | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **A.** | | Water | .. | .. | 0·23 | 0·30 | 0·71 | 1·12 | 1·39 | 1·19 | 1·74 | 1·93 | 2·43 | 2·70 | 3·42 | 3·57 | 2·56 | 3·27 |
| | Foreign substance | Ash | 0·12 | 0·19 | 0·23 | 0·37 | 0·58 | 0·73 | 1·00 | 0·76 | 1·24 | 1·43 | 1·76 | 1·88 | 2·62 | 2·69 | 2·12 | 3·17 |
| | | Organic matter | 0·13 | 0·21 | 0·84 | 0·83 | 1·01 | 0·95 | 1·31 | 1·25 | 1·52 | 1·94 | 2·01 | 2·82 | 2·86 | 3·14 | 2·02 | 2·86 |
| | | Sugar | 99·75 | 99·60 | 98·70 | 98·30 | 97·70 | 97·20 | 96·30 | 96·80 | 95·50 | 94·70 | 93·80 | 92·60 | 91·10 | 90·60 | 93·30 | 90·70 |
| | | Total | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 |
| **B.** | The amount per cent. of purified sugar; assay I. | | 99·90 | 99·90 | 98·32 | 97·05 | 95·94 | 94·10 | 93·45 | 93·59 | 91·36 | 90·25 | 88·98 | 87·20 | 83·70 | 82·95 | 86·70 | 83·60 |
| | ,, ,, ,, ,, II. | | 99·95 | 99·85 | 98·40 | 96·90 | 96·06 | 94·25 | 93·25 | 93·56 | 91·20 | 90·11 | 88·93 | 87·30 | 83·40 | 83·10 | 86·75 | 83·36 |
| | Average of results I. and II. | | 99·92 | 99·87 | 98·36 | 96·97 | 96·00 | 94·17 | 93·35 | 93·58 | 91·28 | 90·18 | 88·95 | 87·25 | 83·55 | 83·02 | 86·72 | 83·48 |
| **C.** | | Coloration | remains unaltered | | white | .. | . | .. | light yel. white | white | .. | .. | light yel. | .. | .. | .. | light colour | |
| | Foreign substances | Ash | 0·07 | 0·08 | 0·09 | 0·07 | 0·10 | 0·09 | 0·28 | 0·04 | 0·20 | 0·23 | 0·42 | 0·49 | 0·67 | 0·50 | 0·66 | 1·38 |
| | | Organic substances | 0·13 | 0·13 | 0·11 | 0·33 | 0·20 | 0·21 | 0·42 | 0·16 | 0·30 | 0·37 | 0·28 | 0·51 | 0·63 | 0·40 | 0·44 | 1·22 |
| | | Sugar | 99·80 | 99·80 | 99·80 | 99·60 | 99·70 | 99·70 | 99·30 | 99·80 | 99·50 | 99·40 | 99·30 | 99·00 | 98·70 | 99·10 | 98·90 | 97·40 |
| | | Total | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 |
| **D.** | Value of sample for refining | | .. | .. | 98·16 | 96·58 | 95·71 | 93·89 | 92·70 | 93·39 | 90·82 | 89·64 | 88·33 | 86·38 | 82·46 | 82·27 | 85·77 | 81·31 |

## RESULTS OF EXPERIMENTS MADE ON THE GERMAN SUGAR STANDARDS.—Continued.

| | Number of the types | 1 | 12 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **E.** Amounts eliminated in washing the raw sugar | Water | .. | .. | 0·23 | 0·50 | 0·71 | 1·12 | 1·39 | 1·19 | 1·74 | 1·93 | 2·43 | 2·70 | 3·42 | 3·57 | 2·56 | 3·27 |
| | Foreign substances: Ash | .. | .. | 0·14 | 0·30 | 0·48 | 0·65 | 0·74 | 0·72 | 1·06 | 1·22 | 1·39 | 1·45 | 2·06 | 2·27 | 1·55 | 2·01 |
| | Foreign substances: Organic substance | .. | .. | 0·73 | 0·51 | 0·82 | 0·75 | 0·92 | 0·10 | 1·24 | 1·61 | 1·76 | 2·38 | 2·33 | 2·81 | 1·64 | 1·85 |
| | Sugar | .. | .. | 0·54 | 1·72 | 1·99 | 3·31 | 3·60 | 3·41 | 4·68 | 5·06 | 5·47 | 6·22 | 8·64 | 8·33 | 7·53 | 9·39 |
| | | .. | .. | 1·64 | 3·03 | 4·00 | 5·83 | 6·65 | 6·42 | 8·72 | 9·82 | 11·05 | 12·75 | 16·45 | 16·98 | 13·28 | 16·52 |
| **F.** Molasses | Water | .. | .. | 20·00 | 20·00 | 20·00 | 20·00 | 20·00 | 20·00 | 20·00 | 20·00 | 20·00 | 20·00 | 20·00 | 20·00 | 20·00 | 20·00 |
| | Foreign substances: Ash | .. | .. | 7·94 | 9·49 | 11·67 | 11·04 | 11·27 | 11·01 | 12·15 | 12·37 | 12·90 | 11·54 | 12·65 | 13·54 | 11·57 | 12·14 |
| | Foreign substances: Organic substance | .. | .. | 41·42 | 16·13 | 19·94 | 12·74 | 13·97 | 16·83 | 14·21 | 16·32 | 16·33 | 18·94 | 14·31 | 16·76 | 12·24 | 11·17 |
| | Sugar | .. | .. | 30·64 | 54·38 | 48·39 | 56·22 | 54·76 | 52·16 | 53·64 | 51·31 | 50·77 | 49·52 | 53·04 | 49·70 | 56·19 | 56·69 |
| | Total | .. | .. | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 |
| **G.** | Coefficient of salts | .. | .. | 2·35 | 4·65 | 3·43 | 4·53 | 3·60 | 4·49 | 3·77 | 3·54 | 3·11 | 3·31 | 3·30 | 3·10 | 3·55 | 2·96 |
| | „ of organic substances | .. | .. | 0·64 | 2·07 | 1·97 | 3·48 | 2·75 | 2·73 | 3·08 | 2·61 | 2·72 | 2·20 | 3·02 | 2·65 | 3·73 | 3·28 |
| | „ of foreign substances in general | .. | .. | 0·50 | 1·43 | 1·26 | 1·97 | 1·56 | 1·70 | 1·70 | 1·59 | 1·45 | 1·33 | 1·58 | 1·43 | 1·82 | 1·56 |
| **H.** According to the coefficient 5 there is found | Amount per cent | .. | .. | 97·55 | 96·45 | 94·80 | 93·55 | 91·30 | 93·00 | 89·30 | 87·55 | 85·00 | 83·20 | 78·00 | 77·15 | 82·70 | 74·85 |
| | Consequently less per cent | .. | .. | 0·61 | 0·13 | 0·91 | 0·34 | 1·40 | 0·39 | 1·52 | 2·09 | 3·33 | 3·18 | 4·46 | 5·12 | 3·07 | 6·46 |

5. The series E indicates the proportion of the substances, water, ash, foreign organic matter, and sugar, extracted from 100 parts of raw sugar by the washing, and constituting the molasses, or residue of the refinery. The molasses of the sugar manufactories have, on the average, 20 per cent. of water, and I have reduced the numbers in this series to those in which an equivalent amount of water is added, and the results thus obtained constitute—

6. The series F.—The best and most brilliant proof of the exactness of my process for the experimental estimation of the value of the raw sugars in refining, for the calculated per centage composition of the molasses from raw sugars gives, with a single exception, the values usually found in practice. These numbers are, then, clearly the touchstone, so to speak, of the process, the proof of the justness of our considerations. Type No. 3 alone gives a molasses of doubtful and improbable composition, but this should not be surprising, for, in consequence of the numerical smallness of the numbers in column E, the errors of analysis may be exaggerated by arithmetical calculations, and it is possible that there may have been an error in some of the other determinations, an error which has given too large a figure for foreign substances. The arithmetical mean of all the values of the molasses, starting with No. 4, inclusive, gives:—

| | | |
|---|---|---|
| | Water | 20·00 |
| Foreign substances (non-saccharine), | Ash | 11·80 |
| | Organic substances | 15·37 |
| | Sugar | 52·83 |
| | | 100·00 |

A result which could not better agree with what is met with in practice.

7. The series G indicates the calculated coefficients of the salts, organic substances, and of the foreign substances in general, such as must be clear to furnish the yield likewise found in experience. The coefficients of the salts, far from reaching the conventional figure 5 of the French Bourse, are far less for some.

This agrees with the experience of German refiners. There appears no other law of correlation from these numbers; in fact, none justified by other considerations. I will say as much in regard to the coefficient of organic matters, and of foreign substances in general. Their values show that it is necessary to diminish somewhat each coefficient before fixing upon it, and that the coefficients recently proposed by me at the last general assembly (see *Zeitschrift*, p. 477), for foreign organic substances, was equally defective and inadmissible.

8. The series H indicates, finally, the results obtained according to the conventional French coefficient 5, and the proportions of sugar which, in consequence of and by comparison of the experimental data, are taken less into account. The last differences show clearly that the employment of the coefficient 5 furnishes results the more inexact as the sugar under examination is richer in salts.

The preceding researches and results, on the question before us, show that a process for determining the yield of raw sugars is possible—that is, the real and experimental elimination of the crystallized sugar from samples of raw sugar, and the determination of these proportions in chemically pure sugar.

This separation is effected in an easy and accurate method by means of the process which we have just examined. According to this process, the value of the same is presented in a visible and palpable form, and the value is determined by the balance, and not by a problem which shows nothing. This method of analysis equals in precision the polarimetric process: for the difference in the results of the duplicate analyses (see B, I. and II.) for the large grained and clearly crystallized sugars, for fine grained at the most only 0·1 or 0·15 per cent.; for samples of first grade polarizing, 92° or 94°—at the highest 0·2 per cent.—and for samples polarizing a degree less, only about 0·2 or 0·3 per cent. The process is, besides, rapid and exact in execution; for a great number of analyses may be daily executed, when a sufficient number of filter tubes are at hand, which at least are not expensive. As a proof of the process, I can say that not a single one of my analyses has failed.

One other result is that the process will give everywhere and always the same results to different analysts working on the same samples. These results are not dependent, as in the polarimetrical assay, on the delicacy of the apparatus or the sensitiveness of the observer's eye. There is needed only a balance sensitive to ·01 gramme, and solutions rightly prepared. They can, however, in consequence of careless preparation, cause a mistake by not being thoroughly saturated; but it is easy to detect this by a preliminary analysis, which should always be made when a fresh solution is prepared. A dried refined sugar is selected which is treated according to the process. The weight of the sample should remain the same. This process is besides so easy of execution that the most ignorant in chemical manipulation is sure to obtain good results. On consideration of these advantages I have hopes of seeing my process, however little new and original, judged as offering the complete solution of the question presented for competition.

An old process such as Payen's—an historical process (for during the past twenty-five years it has not been applied), perfected and adapted to the wants of industry, constitutes, it seems to me, a task as meritorious as the discovery of a process founded on a new basis.

*(To be continued.)*

## THE SUGAR CONFERENCE.

In April last the French Government issued an invitation to the Governments of Belgium, Great Britain and Holland to send representatives to a Conference in Paris, to resume the consideration of the question raised at the Conference held in London, in August last, whether any system of chemical analysis or scientific examination could not be discovered which from its simplicity might be applied to the assessment of the duty on sugar, in the four countries above named?

It will be remembered that the London Conference, in August last was convened by the British Government to consider the expediency of adopting in all four countries a system of refining in bond, with a view to the suppression of bounties derived from the exportation of refined sugar. At that Conference the Belgians positively refused to accede to any such proposition, principally on the ground that it was opposed to their political system, which carefully excluded all restrictions on trade. The Dutch expressed their opinion that refining in bond could only be adopted as an extreme measure when all other systems were proved to be useless for the desired object, and that they considered that chemical analysis might be advantageously adopted as a basis of assessment. The French representatives alluded to the recommendation of their *Conseil Superieur* that refining in bond was preferable if it could be carried out under uniform regulations in all four countries, but as Belgium totally dissented, and Holland would only assent on certain conditions, there did not appear to them to be any chance of arriving at such a unanimous acceptance as was contemplated in the recommendation of the Council, and therefore, they, the French representatives, did not feel justified in giving their assent to the proposition. Under such circumstances, the representatives of Belgium, France, and Holland proposed that the enquiry above alluded to should be submitted to the respective Governments, and the British representatives so far yielded to the opinion of the majority as to agree to submit the question to their Government. The proposed enquiries were instituted by the four countries and it was with the view to consider the result of these enquiries that the French Government called for the reunion of the Conference at Paris. The first meeting took place on the 19th April, under the presidency of the Minister of Commerce and Agriculture, M. Teisserenc de Bort, who continued to preside over all the other meetings, of which there were several, the last being on the 3rd May.

It appears from the enquiries we have been able to make that the opinions of the representatives of the different countries remained very much the same as at the former Conference. The English representatives pressed the acceptance of the proposition of the British Government that refining in bond should be adopted as the only satisfactory means of repressing bounties. But this was still more resolutely refused for the same reasons and by the same parties as on the former occasion, and the only resolutions that could obtain unanimous acceptance were that colour should not be taken as the sole basis of assessment, but that sugars should be assessed according to their strength and that recourse might be had to chemical analysis to determine that strength; that the charge for duty in respect of beetroot sugar when assessed in the juice should be raised to 1600 grammes, and that France should establish the correlation between her duties and drawbacks.

This is, we believe, a correct outline of the proceedings of the Conference: the papers containing the official reports aud minutes of the meetings have been called for in Parliament but have not yet been laid before the House; when they shall have been published we shall be in a better position to give more exact information and to form a judgment as to the result.

## ENQUIRY INTO THE USE OF THE SACCHARIMETER, AND OF CHEMICAL ANALYSIS FOR THE ANALYSIS OF RAW SUGARS.

(*Continued from page* 316.)

### Question II.

*Is not this method of procedure more exact than that of colour for determining the saccharine richness of sugars?*

### Answers.

M. Angenot, Antwerp. The joint method is without doubt a more exact method of determination than that of colour, which is at present really used to determine the classification of sugars by the Custom House. A classification based on colour is nearly always erroneous; it is thus necessarily a notable cause of profit or loss to those interested. This point is always proved by the last evidence. When a series of samples of indigenous sugar, numbered the same, are analyzed, it is found that the difference in crystallizable sugar, which varies from 1 to 5 per cent., makes an error of from 1 to 6 francs at an average, in the buying price.

When exotic sugars are in question, these differences are still greater. Thus, a cane sugar No. 12, might titrate the same amount as certain products, Nos. 18 or 19, of which the colours are very different. (See M. Emile Nouvier, *Guide for the assay and analysis of foreign and indigenous sugars*, p. 57. Results of 200 analyses of sugars, classed according to colour. Paris: Eug. Lacroix, publisher; with Mayolez, Brussels.)

We have added to our report the results of careful analyses of twelves samples of exotic sugars* in order that the truth of this may be seen: *colour is the worst method that the custom house can employ for determining the value or amount of refined sugar in raw*

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* *Results of the analyses of twelve samples of cane sugar, classified according to colour.*

PRODUCTION OF SUGAR.

| | British Guiana. | British Gniana. | Java. | British Guiana. | Port Natal. | British Guiana. | British Guiana. | British Guiana. | Java. | Port Natal. | British Guiana. | British Guiana. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | NUMERICAL ORDER ACCORDING TO COLOUR. | | | | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| Crystallizable Sugar | 88·41 | 91·94 | 93·29 | 95·40 | 95·10 | 96·10 | 95·02 | 94·93 | 96·85 | 98·01 | 96·06 | 97·20 |
| In „ „ .. | 6·19 | 3·76 | 3·60 | 2·29 | 2·15 | 2·02 | 3·29 | 3·19 | 1·50 | 1·05 | 2·51 | 1·75 |
| Salts or Ash ...... | 1·31 | 1·20 | 0·73 | 0 54 | 0·21 | 0·41 | 0·21 | 0·14 | 0·55 | 0·07 | 0·01 | 0·05 |
| Moisture .......... | 2·99 | 2·02 | 1·44 | 1·02 | 1·21 | 0·72 | 0·68 | 0·94 | 0·40 | 0·11 | 0·82 | 0 58 |
| Unknown ........ | 1·10 | 1·08 | 3·94 | 0·75 | 1·33 | 0·75 | 0·80 | 0·80 | 0·70 | 0·76 | 0·60 | 0·42 |
| | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100·00 | 100 00 |
| | 75·67 | 82·18 | 86·04 | 90·41 | 91·90 | 92·13 | 90·68 | 91·04 | 92·60 | 96·61 | 93·50 | 95·40 |

From these results we may conclude that classification by colour is a very incorrect method for raw sugars. It is thus seen by considering the table, 1st, that No. 2, which differs very little in colour from No. 1, titrates, however, 6·50 per cent. more than it, that is to say, that in refining, 1 ton of sugar will give 130 lbs. more of pure sugar than No. 1; 2nd, that Nos. 4 and 7, which are different in colour, give nearly the same amount of pure sugar; 3rd, that No. 10 would give 3 per cent. more sugar than No. 11, whose colour, however, is clearer.

If it had been possible to have made more analyses of a greater number of samples, there is no doubt that even greater differences would have been found.

*sugar:* 1st, because sugars of the same colour might contain different proportions of crystallizable sugar; 2nd, because sugars of very different colours might be of nearly the same, or the same saccharine richness.

As to the causes which produce these phenomena, the principal are, in the first place, the nature of the crystals, which are large or small grained; and in the second place, the presence of foreign substances in the sugar. These substances are either strongly *coloured* (the colouring matters of cane and beetroot), or *colourless* (water, glucose, mineral salts, acids or other organic bodies). The more abundant these latter substances are in white sugar the less rich it is, whilst the colour is not affected.

Again, in a coloured sugar the colouring matter may gain in intensity without gaining in weight, and consequently may affect differently the colourless matters, whatever they are; it is thus shown that determination by colour is the most defective method which can be employed in the present state of our knowledge.

M. Boyard, Brussels. This method of analysis, which is exclusively employed in buying and selling raw sugars, shows, more exactly than by the colour, the saccharine richness of sugars.

The saccharine richness of sugars really depends solely on the amount of crystallizable sugar which they contain; the colour cannot give a real idea of this richness.

Numerous analyses have proved that a dark sugar, having clearly defined crystals, is often richer than a white sugar having badly defined crystals. It was found in analyzing fifteen samples of French sugar, No. 12, that the amount of crystallizable sugar they contained varied, according to the form of their crystals, from 93 to 97 per cent.: being a difference of 4 per cent. On the other hand, these sugars showed a difference of 11 per cent. in refinable produce, owing to the very different amount of salts which they contained.

In the examination of seven samples of Belgian sugar, No. 12, a difference of 3 per cent. in the crystallizable, and of 10 per cent. in the refinable product was found.

Chemical analysis shows the absolute saccharine richness of sugars; the colour, on the contrary, gives no exact indication, and is incapable of assigning any positive value to the sugar.

M. de Koninck, Liége. No comparison is possible as to exactitude of results between the saccharimetrical assay and classification according to colour. Whilst by the former method results are easily obtained, varying among themselves to less than 1 per cent., classification according to colour brings under the same class sugars of which the amount of crystallizable sugars varies as much as 10 per cent., or even more. The difference is still greater, if, instead of considering the *amount present*, the *amount produced* be considered, that is to say, the amount of richness in sugar which can be extracted in manufacture; in this case, the error of classification by colour may reach 20 per cent., and even exceed this amount. This enormous difference proceeds from the fact, that the presence of salts in the sugar exercises an enormous influence on the manufacture, whilst this influence is not at all, or very slightly, shown in the colour.

The classification by colour-types offers great convenience for fraud; nothing is simpler, in reality, than to add a colouring matter to a sugar which will make it descend two or three numbers in the scale, without reducing it in value.

M. Donny, Ghent. This method gives more exact results than the colour method.

M. Dufour, Antwerp. Colour is a useful but insufficient index of the saccharine richness of sugars; the saccharimetrical method cannot be dispensed with.

M. Groullard, Liége. The saccharine richness determined by observation of types or of colour, gives merely an approximate idea of the value of sugars, and this method of approximation loses day by day the value attributed to it, in presence of the new methods of manufacture to which the sugar industry has given birth. Take, as a proof in support of this assertion, a slight glance at the analytical results obtained by Dr. Landolt, of the University of Bonn, who was commissioned in 1866, by the Prussian Minister of Commerce, to make researches into the produce of refineries of raw sugar.

| Type. Dutch. | Sugar. Crystallizable. | Ash. Per cent. | Water. Per cent. | Produce. Calculated to co-efficient at 5 per cent | Observations. |
|---|---|---|---|---|---|
| No. 12 | 93·0.0 | 3·70 | 3·10 | 74·50° | |
| | 93·00 | 3·30 | 2·70 | 76·50° | |
| | 91·60 | 3·00 | 3·00 | 76·60° | |
| | 90·70 | 4·60 | 4·30 | 67·70° | |
| | 93·80 | 2·10 | 2·80 | 83·30° | |
| | 92·50 | 2·40 | 3·50 | 80·50° | |

An inspection of the preceding table, containing the results of analyses of sugars considered as belonging to the same type, will show that the saccharimetrical error may rise to 3 per cent., that of the ash to 2·50 per cent., and that the production refined, calculated to the co-efficient 5, shows the enormous difference of 15·60°.

I might have chosen a series of analyses of sugars belonging to other types, and they would have presented similar anomalies. It appears useless to me to insist on the degree of exactitude this method offers over that based on the classification of sugars according to types, colour, &c. I shall only add one word, and that is, that in England, they have thought to diminish the faults of this system by multiplying the number of types; but in presence of the new products actually furnished by sugar industry, their number must become yet larger, and the classification of sugars, according to this system, will become an inextricable labyrinth.

M.M. Haccour and Pardy, Antwerp. The percentage amount of sugar is determined much better by this method, than the determination of the value by simple observation of colour.

M. Hanuise, Mons. This is a very exact method, but requires a chemical expert, as there are methods of adulteration which a chemist should be able to discover at once.

M. Lembourg, Quiévrain. This method, when rendered more complete by various accessory operations, such as incineration, and determination of incrystallizable matter, when performed by an able expert, gives, with an almost rigorous exactitude, the saccharine value of all raw sugars, and suffices for the determination of the value of refined sugar, whilst the colour method only gives an uncertain value, and assists fraud.

M. Semmel, Ghent. Yes; still it is liable to:

1st. Instrumental errors;
2nd. Errors of manipulation;
3rd. Errors incidental to the method.

M. Wachsmuth, Antwerp. The analytical method shows the saccharine richness of sugars more exactly than the colour method.

*(To be continued.)*

## THE LABOUR QUESTION.

The relationship of employers and employed in this country has reached a serious crisis. Indeed, through the International, it may be said to be a European crisis.

Until lately, in England, labour was as little systematized as any other division of the social organization. Supply and demand was the only known law; skill, sobriety, and industry were the only introductions; certain classes of skilled labour congregated in particular centres, like merchants to an exchange, and wages were regulated by necessity, competition, or the activity of trade. But now all this threatens to be changed.

"Union is strength," say the men, but forget that, although good to have a giant's strength, it is not good to use it like a giant: they promise to do so to their own destruction.

When bodies of men combine to work only for a certain time and a certain wage, the old law of supply and demand is practically in abeyance. When the best workmen dare not earn a higher wage than the most unskilful of his craft, all incitement to superiority is withdrawn. When men dare not do more than an average day's work, under penalties to his fellow labourers—and that average a low one—a premium is offered for universal laziness, and industry is garrotted.

Thus, after a short day's work, in which only half work is done, a strong animal, with all his energies undrawn upon, is thrown loose upon the public, with a pocket full of money, and only one idea of how to spend it. The result is seen everywhere around and within our large cities. Men are losing their habit of labour, drink and debauchery are sapping the foundations of their energy and their powers of application. Their families, in place of being benefited, complain that big pay and little work means ruin to them. No one is bettered. It is a sort of French Revolution in its way, in which the poor are crushing themselves dragging down the rich. The horse has found the use of its legs and is kicking to pieces the splashboard. What is to be done? Let us first see what has been and is being done. In most cases in which the change could be effected, employers have endeavoured to introduce women, to replace, as far as possible, the unmanageable males; and, where practicable, it has been eminently successful. It is the most natural, and, consequently, most sensible movement during a period of social revolution; for are not women the conservatives of social life, fearing to lose by any rude change, knowing that the *statu quo* is at least safe, and too timid willingly to precipitate a social convulsion.

The effect of the extensive employment of the other sex is much more considerable than will appear at first sight, for not only does it reduce the scale of wages in that particular department of labour, but throws a body of male employées into other departments where the women have, as yet, been unable to enter. These men will be non-union, and obey no law but necessity. Thus, twenty years ago, when the Ayrshire colliers were unmanageable, and the Ayrshire weavers out of work, the fathers of the present malcontents left the shuttle for the pick, and ended the employers' difficulty and their own distress.

Leaving aside the family question, woman's labour is cheaper mainly on account of her more temperate habit of life; and the remuneration upon which she maintains her respectability is a standing reproach to those who "cannot exist" on double the money.

There is one point in connexion with the employment of women which appears to us to be the subject of grave misconception. That is, the dislike the public entertain towards out-door labour for women. Why should it better befit a woman to sing a song of the shirt than join in the labours of husbandry; to grow round-shouldered over a sewing machine, than to employ her vigorous animal nature in the garden or the field? We pride ourselves on our treatment of women, and talk as if coddling them into useless inanities, or drawing-room ornaments, were a sign of our civilization; can workmen support such? If we are to look forward to a race of vigorous undegenerate working men, we are more likely to obtain them from working mothers, with healthy instincts and strong frames, than from the sickly, narrow-chested girls, we prefer to foster. Woman is essentially a worker, and will set about and *do* something, when a man sits down to think. We contend, then, that out-door labour, of the most energetic description, is peculiarly fitted for the women of the working classes, and that it is in every way a more womanly occupation, and morally and physically superior, to our present domestic service. Let people properly consider this, and without pushing them into degrading employments, many more avenues of labour will be thrown open to women, concentrating the increasingly valuable male labour where it is absolutely necessary.

The attempt to decide the question of labour by an extension of the principle of co-operation—making the men fair-weather partners—can never be generally successful. It is wholly inconsistent to give a body of men a share of the profits of a concern during a time of prosperity, when they cannot be called upon to pay their share of losses when the day of adversity comes. This, of course, does not apply to the case of the men subscribing the working capital and securing a salaried manager, a possibility, when our working classes learn habits of industry, temperance, and thrift—a result—seemingly further distant than ever.

A London bricklayer offered to lay as many bricks in one hour as his union permitted in a day. A potter was pulled up by his union because, by his industry, he made twice the wage allowed. "Thou shalt not be better off than I am" has become their law. And again, we say, the worst effect is in the future. Unwrought men are dissatisfied of necessity. Ask any employer about the men who have lately "gone in," after a strike or lock-out, and you will find they are merely nominally at work, they have become demoralized and unfitted for continuous labour. The lowest class of workmen are those that "play" often. Colliers have always been peculiarly rough and troublesome in this country, not from the nature of the work, but because they play, as a rule, two or three days a week. This is not the case in Germany. Intermittent labour, unquestionably, unsettles the mind; and, in the interest of the men themselves, it is important they should have strict discipline, and not too much leisure, otherwise they will become as degraded and uncontrollable as an unemployed soldiery.

To talk of education and Mechanics' Institutions effecting a cure is wholly to misunderstand the nature of physical avocations. That many men will take advantage of the overtime to improve their minds, and advance themselves in the social scale, we hope and believe. But it is an exceptionally vigorous constitution that can devote itself to serious intellectual pursuits after the physical labour of the day. Our experience leads us to believe that very few men are constitutionally capable of this, either amongst the middle or lower classes, supposing even their minds had such a bent.

A cry has been raised for Government interference in the interest of the country. Fortunately, we are not yet possessed of a "paternal" Government ready with hasty laws for every contingency. We would rather believe that the evil will right itself, and trust more to the common sense of the workmen themselves, and the pressure brought to bear upon them by their wives and families, who are necessarily the most serious sufferers in the struggle. For it has always been an acknowledged fact, among employers, that the highest paid classes of workmen are the least happy in their domestic arrangements.

In that portion of the outer Hebrides, known as The Lews, there is a large body of labourers mostly employed in the cultivation of their own little crofts, varied by fishing during a portion of the year. These people are far superior in physical comfort, and, indeed, in "mentality," to the workmen of our large cities. Yet, their average yearly income would certainly not exceed £10, plus the potatoes and grain of their crofts, which, to a great extent, are managed by the women and children. Consequently, nowhere can you see a more vigorous body of women, or healthier families, than in this northern waste. Even there, however, there are degrees, and, where the savage nature of the coast has formed more energetic habits among the men, the community is far better off, in every respect, than in those otherwise more favoured districts, where laziness is king, and "to-morrow" their god.

A still more striking example of this difference may be witnessed all along the West Coast of Scotland. Boats of inferior build to the native fishing boats come every year from the East Coast, manned by the hardy fishermen who are energized by the struggle with the German Ocean, and reap the fish harvest nature apparently had sent to others. Their success is proportioned to their energy and enterprize, as they pursue their calling in all weathers, and continue to set their lines and trust to an average return, when the lazy aborigines can see no inducement to launch their boats. "Suffer and be strong;" and we generally see those bodies of men to whom life has been too easy, lack the mental stimulus to exertion.

Again, cheap labour and dear labour may be said to be equally unprofitable, another example of the "falsehood of extremes." In the Lews we have employed able-bodied men at from 7s. 6d. to 9s. per week, without food or lodging. This was quite the customary scale of prices, but, as a rule, the work done was little, and unsatisfactory. Indeed, employers were sometimes in the habit of sending to the mainland for workmen, and paying them about three times this wage, asserting they were really cheaper in the end.

From these considerations it is apparent, that for the successful prosecution of any undertaking requiring a body of workmen, it is important the hours should not be too short; that the wages be reasonable, neither excessive nor the reverse; that, if possible, decent cheap accommodation be provided for their families; an *esprit de corps* established; and self-respect induced. Whether the national vice might not also be curtailed by judicious legal enactions, following the footsteps of the Swedes, has become a question. Our so-called liberty has, indeed, advanced into the region of license, and when men's ideas of freedom interfere alike with the comfort and happiness of themselves, their families, and the public, a wholesome discipline seems not uncalled for. It may also be accepted as pretty certain, that until unions are greatly modified, if not entirely changed in character, the average workman will continue to deteriorate. The best workmen, as a rule, are naturally averse to them, as they prevent the extra remuneration due to their superior skill and energy, and while, at first, endeavouring to procure for the poorest workman the wages of the best, really end, in the natural course of things, in reducing the pay of the ablest to that of the most unskilful. This, naturally, drives the best men out of the country, and would be a more purely national question, if it were not at present a universal one.

For the minds of all men who have labour to sell have become unsettled, they do not know its true value compared with other commodities, and no doubt it will end in procuring from capital a larger share of the returns of business, seeing the accumulated wealth of the civilized world has distinctly lowered their respective values. Capitalists may be unwilling to accept this view of the subject, but even taking capital in its form of labour-saving,—and consequently labour-representative,—apparatus and machinery, the return upon it is already exceedingly small on an average, and the labour which it represents will no doubt follow in its wake.

But employers are not unwilling to advance wages in accordance with the decreased value of money, viewed in respect to what it will buy, if it were not for the indubitable fact, that so far as we have yet gone, increased wages means dissipation and decreased production. Under these circumstances employers should take a deeper interest in the home life of their workmen, and, without being Paul Prys endeavour to improve their dwellings, offering premiums for temperance and domestic comfort. The best men would be attracted to those establishments where the superiors made arrangements for their social amelioration, and where a moral support was given to any man endeavouring to improve himself and better his condition. At present a few reckless men may leaven unwholesomely the whole body. In the Island of Uist, owned by Sir J. Orde, and leased by the British Seaweed Company for kelp manufacture, the kelp is made by the cottars scattered round the coast, the rent of their crofts is retained out of the money due them by the Company, and handed over to the proprietor. In this way the people are generally clear of debt, and in comparatively comfortable circumstances. Both proprietor and cottars are greatly benefited by this system. In the same way if workmen's dwellings were as far as possible provided by their employers, and the weekly rent regularly deducted from their earnings; co-operative stores established; and habits of thrift and sobriety encouraged, much more might be done than there is at present in elevating the character and improving the position of the working population.

In many slave lands it has been the custom to allow the slave to purchase his freedom by his earnings after his regular work is over, and the many who have thus obtained their emancipation might be a lesson to those highly paid workmen who squander their earnings in riotous living, and then shriek through some blatent mouthpiece, "my burden is greater than I can bear!" The men have discovered their power for evil, let them be quietly taught their power for good, and like the kicking horse guided by a skilful hand, they will ere long drag harmoniously along the social vehicle they now threaten to destroy.

*9th June, 1873.* W. ANDERSON SMITH.

# THE VACUUM PAN, THE CONCRETOR, THE WETZEL, AND THE BATTERY, IN SOUTH AFRICA.

The following extract from a letter just received supplies valuable data, and affords means of comparison of the various processes of sugar making :—

Isiping, Durban,
Natal, S.A., April 21st, 1873.

* * * The average result of my work with the Concretor, during the last twelve months, on China cane (much of it of inferior quality,) is 1¼ lbs. of dry sugar per gallon of juice, varying in density from 8½ to 10½° B., mostly 9° B.

By what you call the Jamaica train without Wetzel, in previous seasons, I could not from superior cane obtain above one pound per gallon of juice, of sugar worth at least two shillings per cwt. less than that made by means of the Concretor.

My crop of China cane has yielded 984 cwts. 2 qrs. of sugar; of this quantity 197 cwts. were treacle sugar net receipts £1016, average £1 0s. 7d. per cwt. The difference as compared with the ordinary Jamaica train, in my case, is that by means of the Concretor I have got 12 tons more sugar, and through improved quality and colour an enhanced price and ready sale, or to put it plainly I have received about £300 more than I should have received had I worked on the old system.

Now in comparison with other systems, I have to observe that Mr. A.'s mill is near to mine, and I have full information respecting it, as all accounts relating to the estate pass through my hands. The Jamaica train and Wetzel are employed. There is an ample supply of clarifiers, and rapid evaporation in the pans, whence the syrup is transferred to the subsiders at a density of 28° B. Cane densities, weather, and other external conditions alike in this case and mine. Every attention is paid to economy. Beautiful granular sugar is often made almost white. From the molasses a nice sugar is produced, and the treacle from this is made to produce a third quality, and no more can be extracted by colonial skill and appliances.

The proportions are: 70 tons first sugar; 33 tons 14 cwts. second; 21 tons 6 cwts. third; total 125 tons. The total product will not average quite one pound of sugar per gallon of juice. The nicest sugar made at Mr. A.'s mill is now selling at 27s. per cwt., in Durban twelve miles distant. My best sugar is now selling, by the same agent, at 25s. per cwt., but of this sugar at 25s. I am getting one pound per gallon of juice, while the manager at Mr. A.'s gets little more than half a pound of his best sugar per gallon of juice. 118 tons sold for £2359, or an average price of 21s. 0½d. per cwt.

At another estate, in this vicinity, where the usual hemispherical pans are used in conjunction with Wetzel pans, the produce of sugar throughout is 15½ ounces per gallon of juice. This is the average of perhaps 200 tons. Again, at the largest estate, in this neighbourhood, with machinery equal to six tons of sugar per day, and where a vacuum pan is employed, the manager informed me that for the last season the total yield of all classes of sugar put together was a little under one pound to the gallon of juice. The proprietor came over to see the Concretor here, a while ago, and there is no doubt that if he has not already ordered one of the largest size he will do so soon. I may add that Mr. A.'s first treacle sugar sells for £1 per cwt. and mine the same. His seconds sell at 15s. and 16s., prices are high now. They fluctuate and qualities vary, but the proportions I have indicated will hold good generally. (The price of the vacuum pan sugar is now £27 per ton in Durban.)

I now come to another point in favour of the Concretor, and that is the great saving of labour effected by its use. The heavy monotonous work of skimming and ladling is avoided. I think that to do the same quantity of work, or rather to produce the same quantity of sugar, four or five more men are employed at Mr. A.'s mill.

You are at liberty to make what use you please of this letter, and employ the facts stated therein in any way you may deem conducive to your interests. I crushed last October, for a neighbour, cane from 3 acres of land, green Natal cane, density 10° B., and obtained 13,800 gallons of juice, which produced 18,798 lbs. of dry sugar. (1·36 lbs. of dry sugar per gallon and 56 cwts. of dry sugar, not concrete, per acre, made by means of the Concretor.)

I am, dear Sir,
Yours truly,
Laurence Platt.

I am crushing cane now which is a mixture of green Natal and China cane, over ripe, being two-and-a-half years old. I am getting of first sugar from it much more than 1 lb. per gallon; density, 10° B. Price of the sugar 25s. per cwt. Nice colour, but little grain.

I find, also, a great saving in fuel, so great that I have enough to spare of megass to half supply the engine boiler, one of Howard's. Wood is getting scarce and fuel is a most important item with coal at £3 10s. per ton.

## CYCLONE IN THE ISLANDS OF REUNION AND MAURITIUS.

The Island of Reunion, which has undergone so many misfortunes during the last ten years, has recently been devastated by a cyclone, of which the violence exceeded that of any hurricane of which the inhabitants have any recollection. The disaster is felt so much the more in that our colony afforded prospect of most splendid crops which would have restored the deficiencies of recent years. Many sugar manufactories have been laid bare and shaken, numerous buildings have fallen down, and large quantities of beasts have been crushed under the *debris*. Bridges, highways, works of art, communal buildings, and also the houses in villages and hamlets have suffered considerably. The town of St. Paul has been partly submerged, and boats had to be used to save the inhabitants. It is difficult to estimate the devastation in the crops of sugar, it appears considerable, and it is supposed that the loss will amount to fifty per cent. We give this estimate, however, under reserve.

The same cyclone has swept over the Island of Mauritius, and it is reported from that Island, that independently of the delay in forwarding the sugar, it will have the effect of reducing the production of the present season, for the large canes still standing have suffered seriously, and no doubt the yield will be proportionately affected. The young plantations, not having as yet obtained their full development sustained little injury, and it is even probable that they will be improved by the heavy rains which have accompanied the phenomenon. The effect of the long draught in the beginning of the cutting of the canes, the continued rain which followed, and lastly the cyclone, have strangely modified the first estimate of the present crop, which was generally put down at 150,000 tons. At the present moment, if 125,000 or 130,000 tons can be obtained, the planters may consider themselves fortunate.—*Journal des Fabricants de Sucre.*

## No. 6.

Ammonic Phosphate as a Purifier for Syrups.—When the amount of salts, especially of alkalies, passes a certain percentage in a sugar liquor, a mass is obtained from which it is exceedingly difficult to crystallize sugar. In such cases the use of ammonic phosphate is recommended, which gives insoluble phosphates, and gives ammoniacal salts, or, with free alkalies and alkaline earths, gives free ammonia, which can be eliminated by boiling or passing through bone-black.—*Zeitschrift für Zuckerindustrie.*

### No. 7.

THE FAULTS OF THE POLARISCOPE TEST OF SUGARS: THEIR CAUSES, AND THE MEANS OF AVOIDING THEM.—B. Haas.—These are—

(A) Faults in the method of examination.
(B) Faults in the instrument itself.
(C.) Faults induced by subjective phenomena.

(A) The method adopted by some of using a solution of a given specific gravity is correct only for pure sugar, and for others is necessarily faulty, giving results too small by 1 to 1½ per cent. Besides this, there are incorrect determination of the zero point, incorrect weighing, screwing the ends of the tube too tight, lack of uniformity in the temperature, insufficient mixture of the plumbic acetate with the sugar solution, not filling the measuring flask exactly, incorrect weights and measuring flasks, presence of alkaline earths (1 part of lime neutralizing the effect of 1·12 parts of sugar). The presence of caustic alkalies and their carbonates has a similar effect. Presence of asparagine and aspartic acid (the former rotates the ray to the right, the latter to the left). Presence of metapectic acid (1 part metapectic acid neutralizing the effect of 1⅓ parts cane sugar). Alcohol alters the rotatory power of inverted sugar. Inversion by hydrochloric acid causes a coloration of the solution, which detracts from the exactness of the determination. Oxalic acid is to be recommended instead. Syrups and molasses contain so many substances which affect the light that results with them can only be considered as approximate. Basic lead acetate alters the indications of inverted sugar so as to give unreliable results. The accuracy is always greater the larger the precipitate produced in clearing the solution of any sugar.

In the second case (B), faulty construction of the quartz prism attached to the scale. The relation between the rotatory power of quartz and that of sugar not having been exactly determined, another element of uncertainty is introduced, inaccuracy in the length of the tube, improper annealing of the glasses covering the ends of the tube.—*Zeitschrift für Zuckerindustrie.*

### Stocks of Sugar in the Chief Markets of the World on the End of April, for Three Years, in thousands of tons, to the nearest thousand.

| | 1873. | 1872. | 1871. |
|---|---|---|---|
| Great Britain | 145 | 83 | 108 |
| France | 111 | 59 | 92 |
| Holland | 63 | 46 | 33 |
| Germany (Zollverein) | 20 | 23 | 33 |
| Six other *entrepôts* | 8 | 3 | 3 |
| Total in Europe | 347 | 214 | 269 |

### Consumption of Sugar in Europe and the United States, for Three Years ending 30th April, in thousands of tons.

| | 1873. | 1872. | 1871. |
|---|---|---|---|
| Great Britain | 708 | 697 | 726 |
| France | 253 | 287 | 367 |
| Germany (Zollverein) | 262 | 182 | 154 |
| Holland | 27 | 24 | 27 |
| Six other *Entrepôts* | 105 | 109 | 93 |
| Total in Europe | 1,355 | 1,299 | 1,367 |

### Estimated Crop of Beet Root Sugar on the Continent of Europe, for the ensuing Season, compared with that of the three previous Seasons.

*(From Licht's Monthly Circular.)*

| | 1872-73.<br>Tons. | 1871-72.<br>Tons. | 1870-71.<br>Tons. | 1869-70.<br>Tons. |
|---|---|---|---|---|
| France | 395,000 | 335,000 | 289,000 | 289,000 |
| Germany (Zollverein) | 260,000 | 189,000 | 263,000 | 217,000 |
| Austro-Hungary | 205,000 | 162,000 | 182,000 | 151,000 |
| Russia and Poland | 150,000 | 90,000 | 135,000 | 133,000 |
| Belgium | 80,000 | 72,000 | 56,000 | 44,000 |
| Holland and other Countries | 35,000 | 25,000 | 17,000 | 12,000 |
| Total | 1,125,000 | 873,000 | 942,000 | 846,000 |

# SUGAR STATISTICS—GREAT BRITAIN.

To 14th June, 1873 and 1872. In Thousands of Tons, to the Nearest Thousand.

| | STOCKS. | | | | | | IMPORTS. | | | | | | DELIVERIES. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. |
| British West India | 16 | 3 | 2 | 17 | 38 | 22 | 31 | 6 | 5 | 23 | 65 | 58 | 32 | 4 | 5 | 22 | 63 | 59 |
| British East India | 13 | 2 | .. | .. | 15 | 4 | 15 | 3 | .. | .. | 18 | 8 | 11 | 4 | .. | .. | 15 | 11 |
| Mauritius ...... | 4 | 1 | 1 | 2 | 8 | 5 | 9 | 2 | 11 | 11 | 33 | 29 | 10 | 2 | 11 | 9 | 32 | 31 |
| Cuba .......... | 3 | 6 | 1 | 7 | 17 | 12 | 1 | 5 | 4 | 10 | 20 | 26 | 3 | .. | 3 | 14 | 20 | 24 |
| Porto Rico, &c. .. | 2 | 9 | .. | 1 | 12 | 6 | 1 | 13 | .. | 3 | 17 | 8 | 2 | 7 | .. | 2 | 11 | 6 |
| Manilla & Java .. | 25 | 8 | .. | 4 | 37 | 15 | 16 | 7 | 5 | 6 | 34 | 29 | 12 | 5 | 6 | 6 | 29 | 37 |
| Brazil .......... | 2 | 27 | 2 | 6 | 37 | 20 | 4 | 40 | 4 | 9 | 57 | 51 | 4 | 26 | 3 | 9 | 42 | 44 |
| Beetroot, &c. .... | 3 | .. | .. | 2 | 5 | 4 | 16 | 8 | 6 | 17 | 47 | 54 | 18 | 9 | 7 | 27 | 61 | 64 |
| Total, 1873 .. | 68 | 56 | 6 | 39 | 169 | 88 | 93 | 84 | 35 | 79 | 291 | 263 | 92 | 57 | 35 | 89 | 273 | 276 |
| Total, 1872 .. | 31 | 22 | 6 | 29 | 81 increase | | 70 | 60 | 36 | 97 | 28 increase | | 80 | 64 | 36 | 96 | 3 decrease | |

## STATE AND PROSPECTS OF THE SUGAR MARKET.

The agitation caused by the change in sugar duties seems to be passing away and things are settling down into a more normal condition. The steady demand for sugar and the freedom with which holders have met the market have caused very little alteration in the prices.

The stock since about the end of May has been increasing steadily, whilst the price is very far from attaining the height at which it stood before the reduction of the duties.

No. 12 Havana afloat is quoted at 26s. to 26s. 6d. per cwt., as compared with 36s. in 1872; fair to good refining Muscovadoes, 22s. to 22s. 6d., showing a decline of 1s. 6d. from last month; middling to good brown Bahia, 18s. 6d. to 19s. 6d., also showing a slight decline. This decline is to be accounted for by the fact that the refiners are still abundantly supplied and the demand is limited; the transactions which have taken place in cargoes afloat and in parcels on the spot are still very moderate.

The imports for the half year show an increase of 26,484 tons; whilst the deliveries show a decrease of 3,497 tons. Stocks again show an increase of 81,076 tons over those of corresponding date of 1872.

In refined sugar there has been a good demand for all descriptions, with prices rather in favour of sellers. The price of common refined lump is 35s. 6d. to 36s., compared with 42s. and 42s. 6d. in the preceding year, and showing a slight falling off from last month's quotations.

# THE
# SUGAR CANE.

No. 49. AUGUST 1, 1873. Vol. V.

☞ The writers alone are responsible for their statements.

*For Table of Contents, see opposite the last page of each Number.*

## TO OUR SUBSCRIBERS.

With this number *The Sugar Cane* enters upon the fifth year of its existence, and this appears a fitting opportunity to again beg your hearty co-operation.

*The Sugar Cane,* like all magazines devoted to a special purpose, has the almost necessary drawback of being limited to a comparatively narrow circle of readers. This not only circumscribes our endeavours, but prevents us attaining to the fullest extent of our powers. We wish to make our magazine as indispensable to those connected with the sugar trade, as is the machinery they use; but, to be able to accomplish this, we must have the funds only to be obtained by increased circulation or enhanced price. At present, comparatively large as the circulation is, this want prevents us to a great measure from entering upon many fruitful fields of investigation, since the absence of drawings needful to illustrate such articles would limit the value they would otherwise possess for manufacturers and planters.

We shall however in the following numbers, as we have done more than usual in the recent ones, give illustrations accompanying the various papers in the magazine, but if such a course is to be continued our circulation must be increased. We trust that those of our friends who take an interest in the usefulness of *The Sugar Cane* will use their influence to extend the list of its subscribers.

The various numbers of *The Sugar Cane* afford to those connected with the manufacture, as well as to planters, an invaluable record of the many phases through which the industry has passed, and an index to the intellectual activity of the men who are making a minute study of the chemical economy of sugar manufacture. We have treated very fully of Agricultural Chemistry as applied to cane growing, but mere theoretical expositions are of comparatively little value unless accompanied by the experiences of those who are prosecuting this study in those countries where the cane grows. To planters then we appeal for records of their experience; if they will kindly give us the knowledge they have acquired by long observation, and show how their results agree with, or differ from the theoretical teachings of chemical experts, the value will be inestimable both to themselves and those who are working in the same groove. Though all men are fallible, still from many counsellors wisdom can be gleaned.

We would also wish to call attention to our advertising columns. From its wide-spread circulation in Great Britain, the United States, and throughout the Tropics, and from the fact of its being the only magazine devoted to the subject in the English language, *The Sugar Cane* presents peculiarly advantageous opportunities for advertising all matters connected with the Sugar Trade, which will thus be brought before a class of readers who would otherwise lack the opportunity of becoming acquainted with them. More extended use of this means of making known the special wants of those connected with the Trade, would prove a gain to the advertisers and enable us to develope the usefulness of the magazine in the direction previously indicated.

Papers also from the pens of our foreign readers will receive all attention, and we may thus help to put the chemistry of the agriculture of the sugar cane on a secure foundation. There are many interesting points on which even short notes would be peculiarly acceptable to many who are at present almost in ignorance of what is going on in our colonies. For instance, meteorological reports combined with the health or disease of the sugar cane, is a subject on which at present little or nothing has been written, and is one of the most important awaiting investigation.

The beetroot industry, which by its sanguine partisans is believed to be destined to furnish all the sugar consumed in the temperate zones, and thus to affect the ruin of its parent.—The sugar cane industry, owes no small part of its vitality and consequent increase to the excellent means that it possesses in its recognized organs for the record of improvements in manufacture and agriculture and the interchange of ideas. To many among the most thoughtful and discerning whose capital or talents are embarked in cane sugar production, the present seems a time when it is indispensable that the cane should possess as valuable a literature as the beet, and it is for those who unite in these enlightened views to further the interests of the cane by heartily supporting this, the first serious attempt to establish such a standard literature.

## ON THE USE OF WET MEGASS AS FUEL.*

### By Alfred Fryer.

(*Continued from page* 351.)

Amount of Inevitable Loss of Heat from the Use of Wet Megass.—Hitherto it has been assumed that in all the examples considered, the combustion has been perfect. It will be convenient to continue this assumption and leave the difficulties in the way of the perfect combustion of damp fuel for after consideration.

In practice, average dry megass will be fairly represented by quality No. 3, which is composed of ten parts of dry fibre and two parts of moisture. If megass were burnt direct from the mill its average quality would be represented by No. 5, which is ten parts of fibre and sixteen parts of moisture. (See p. 345). The other varieties may for the present be dismissed from notice. One pound of fibre with its associated moisture, making "average dry megass" (No. 3), will furnish 4342 available units of heat, but this is upon the supposition that the sugar in the remaining juice will serve as fuel. Unless megass be dried with great rapidity, the sugar is decomposed and lost, and in this case it will not be safe to reckon more than 20 units as due to the sugar. The available heat will then be reckoned as 4262 units. Wet megass (No. 5) containing one pound of fibre will furnish 3212 units available, being a diminution of 1050 units, or 24·6 per cent. The available heat of a pound of steam coals is 9841 units, so that the loss by using as fuel a pound of fibre made damp (62 per cent.), instead of its being less damp (17 per cent.), is equal to ·107 lbs. of coal.

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* Erratum.—Page 337, seventh line from bottom, for "cane" read *juice*. Page 347, seventh line from bottom, for "160°" read 65°.

Or to express it differently,—one hundred tons of canes passed through a mill which expresses 66 per cent. in juice, which when clarified and cooled to 80° Faht., gauges 10° B., will make 13·2 per cent., or 13 tons 4 cwts. of concrete. It will yield 13 tons of dry fibre, which as it leaves the mill will be laden with juice, and will weigh 33·8 tons. This megass, when caused to lose sufficient moisture to become "average dry megass," will weigh 15·6 tons. It has been shown that the loss of available heat arising from the use of the wet megass (No. 5), instead of "average dry" (No. 3), is equal to ·107 lbs. of coal for each pound of fibre so used. In like manner, the loss arising from the use of 33·8 tons of wet megass, instead of 15·6 tons of "average dry," will be 13 × ·107 = 1·391 tons of coal, or 31·3 lbs. of coal for each ton of canes, or 10·53 per cent. of the weight of concrete in coals.

If a Central Factory which crushes 24,000 tons of canes in a season were to burn wet megass from the mill, instead of "average dry," and such megass could be completely burnt, it would involve the use of additional fuel equal to 333 tons of coals. If these were worth fifty shillings per ton at the factory, it would involve an outlay of £832 per annum. From this amount it would be needful to deduct the cost of labour incurred in megass drying, also the interest, depreciation, repairs, and insurance of megass *loge*. The use of wet megass as fuel would increase the cost of concrete by threepence per cwt., lessened by the expenses above given. *It may be stated roundly, that even at the present high price of coal the use of wet megass will not increase the cost twopence per cwt., provided the megass can be rapidly and perfectly burnt and the heat utilized.*

Effect of use of Wet Megass on Rate of Combustion.—A bonfire fed with dry sticks or shavings may be aptly compared to a fire of dry megass. The long, clear, smokeless flame conveys heat, the intensity of which could not be maintained without rapid combustion of the fuel. When a quantity of weeds or grass is thrown upon such a bonfire the flame at once disappears and a dense smoke supplies its place. Little heat beyond that which becomes latent by converting the moisture into steam is then disengaged; the rate of combustion is reduced and the fire slowly smoulders. The difficulty with which wet fuel can be induced to burn may be illustrated by a familiar example. Dried orange peel burns with great facility, the essential oil contained in the skin assisting the combustion. It is, however, impossible to burn fresh and therefore damp peel; in fact if a piece of peel be forced into the midst of a hot fire it simply chills the surrounding coals, and for a considerable time does not even lose its colour. As the moisture is slowly driven out of the thick skin the edge becomes charred, and little by little the black fringe encroaches upon the yellow surface. No published data from which we can calculate the extent to which the rate of combustion is reduced by the presence of various proportions of water, are known to the writer, but from the foregoing familiar illustrations it will be seen that the rate will be greatly affected by the addition of not less than forty-five per cent. of moisture. The rate of combustion is governed, all other conditions being equal, by the temperature of the burning fuel, and by the supply of oxygen. It has been shown (p. 345) that the maximum temperature of the products of combustion of damp megass (No. 5) is 1160°, whilst that from "average dry" is 1786°, the difference being 626°. The temperature of the products of combustion is not that of the centre of the fire, but these figures serve to show that the difference must at any rate be very great. As the rate of combustion of wet fuel is slow, and as the temperature of the products of its combustion is low, the gases on entering the chimney will be less heated than when dry fuel is employed. The cooler gases produce a diminished draught, and this by lessening the supply of oxygen to the furnace further reduces the rate of combustion. Wet megass is heavy and lies more compactly together than dry: in this condition it opposes and limits the passage of air through the fire and combustion is still further checked in consequence.

If, in the absence of experiment, it be assumed that twice the grate area will be needed to burn an equal quantity of fibre in the condition of wet megass No. 5 that is required to burn it in the average dry state No. 3, the relative extent of grate area required to liberate the same number of available units of heat may be computed. This will prove to be 2·65 for wet megass, to 1·00 for average dry.

The weight of wet megass needed to liberate the same amount of available heat as one pound of average dry is 2·88 pounds.

Sectional Area of Chimney.—On reference to the table at page 345, it will be seen that when average dry megass is used, the volume of gases passing the chimney is 299 cubic feet consequent on the combustion of one pound of fibre, combined with two-tenths of a pound of moisture. Two pounds and six-tenths of damp megass (No. 5) contain one pound of fibre, and in consequence of the greater quantity of steam mingled with the products of combustion the volume of gases in the chimney is 376 cubic feet. It has been shown that one pound of fibre in the dried fuel liberates 4262 available units, and one pound of fibre in the damp fuel liberates 3212 available units; therefore, for the production of equal quantities of available heat in equal time, always supposing that the combustion is perfect, the temperature of the gases in the chimney and their velocity alike, the sectional area of the chimney for the furnace burning damp fuel will be to that of the furnace burning average dry megass as 1·68 are to 1.

Comparing these with chimneys constructed for receiving the products of combustion of coal, the relative capacities will be:—

| | | | Sectional area. |
|---|---|---|---|
| Chimney for furnace burning average coals.. .. .. | | | 1·00 |
| Ditto | ditto | average dry megass (No. 3) | 1·06 |
| Ditto | ditto | damp megass (No. 5). .. | 1·76 |

In practice, however, three circumstances must not be overlooked: 1st. No furnace has hitherto been constructed in which it has been possible to burn as much wet megass as would liberate the same amount of available heat as would be released by the use of dry megass. 2nd. It would not be prudent to provide a chimney (except in rare instances) of capacity only sufficient to take the gases from dry megass. 3rd. The more open character of a megass fire, the greater openings between the fire bars and the circumstance that the flues are not led round about the boilers or coppers, as the flues from coal fires are led round steam boilers, renders it possible to supply the megass furnace with sufficient air without having recourse to very lofty chimneys.

Sectional Area of Flues required for Damp Megass. Molesworth recommends the sectional area of the flue at the bridge of a land steam boiler to be 18 square inches for the evaporation of a cube foot of water per hour; and for tubular boilers the sectional area of the tubes to be 10 square inches for the evaporation of the same quantity of water. It is needful, that for multitubular boilers, the area of tubes shall be accurately proportioned to the rate of combustion. If the area be too contracted the velocity of the gases through the tubes is raised, and the increased friction checks the draught and reduces the power of the boiler; and, if the area be too great the gases do not pass equally through the tubes; soot and dust accumulate in them; and a more costly construction effects no more work. The discrepancy in the two formulæ above quoted is not very great, for in the example of the multitubular boiler much of the heat having been abstracted before the gases reach the tubes their volume is much reduced. It may therefore be accepted that 18 square inches of area are required to pass the gases, when most expanded, from the combustion of as much coal as is needed to evaporate 1 cubic foot of water per hour. Mr. Longridge has shown that the amount of water at boiling point converted into steam from one pound of coal was from

| | | |
|---|---|---|
| Cylindrical boilers. with two flues | 6·86 lbs. to 8·61. | Average 7·60. |
| Ditto ditto with seven flues | 7·09 lbs. | Average 7·09. |
| “Galloway's” boiler .......... | 8·35 lbs. to 8·61 | Average 8·48. |

When the cold water is used to feed the boiler a less quantity of water will be evaporated. Taking this into account it will be fair to reckon that in practice one pound of coal may be employed in converting six pounds of cold water into steam, or 10·4 lbs. of coals will be consumed to evaporate a cube foot of water. It has been shewn at p. 345, that for each pound of coal burnt in the furnace, 651 feet of gases at 600° will ascend the chimney. It has also been shown that the maximum temperature of the products of combustion of coal is 2150°. All gases expand $\frac{1}{490}$ for an increase in temperature of 1°. The gases at their maximum temperature would occupy 2·46 times their volume at 600°, but, as a portion of the heat would be absorbed by the boiler flue before the bridge would be reached, it may be well to reckon the volume of the gases at the bridge at 2·4 times that in the chimney. From these data it follows that the evaporation of one cube foot of water with 10·4 lbs. of coal in one hour, and the products of combustion passing 18 square inches of area at the bridge, the gases will be passing at the speed of 36 feet per second.

Each pound of coal consumed per hour requires 1·73 inches at the bridge.

Furnaces as usually constructed to burn megass require the area at the bridge to be sufficient to permit the easy passage of the gases expanded to the volume due to their maximum heat, for no portion of the heat is extracted before they reach it, as is the case with the gases from the coal fire in the flue of a Cornish boiler. Having found that the velocity of the gases at the bridge should be 36 feet per second, the bridge area of a furnace constructed for the burning of “average dry megass” may be calculated. The maximum temperature is 1786°, and the volume of gases in the chimney from 1 lb. of fibre is 299 cube feet. These, at 1786°, will occupy 2·12 times this bulk, or 634 feet. The sectional area of the flue at the bridge will be ·704 square inches for each pound of fibre consumed per hour in the condition of “average dry megass.”

One pound of fibre with moisture sufficient to make wet megass (No. 5), that is to say, 2·6 lbs. of such wet megass when burnt, discharge into the chimney 376 cube feet of gases and vapour. When these were dilated by their maximum temperature of 1160°, they occupied 1·52 times that bulk, or 572 feet. To attain a speed of 36 feet per second a sectional area of ·59 inches will be required at the bridge.

The relative sectional areas at the bridge for the combustion of so much fuel as produces an equal amount of available heat are:

| | |
|---|---|
| Area at bridge for coal ................ | 1·00 |
| ,, average dry megass (No. 3) | 1·06 |
| ,, damp megass (No. 5).. .. | ·96 |

*(To be continued.)*

## ON THE PRESENT PROSPECTS OF BEET SUGAR IN CANADA.

This most important matter may now be said to be fairly before the Canadian public. For the past three years it has been fully discussed in our principal agricultural and other influential papers, and there are now before the Legislature of the Dominion a series of resolutions relating to the industry, the most important of which is, that the manufacture of beet sugar shall be free of duty for ten years after its establishment; this was brought forward by a strong portion of the opposition, and was so well received by the House, that the Government was induced to promise to take the matter up, and upon this promise the resolutions were withdrawn. Some of the members of the Government, especially the Minister of Agriculture, are known to be strongly in favour of encouraging the manufacture; the whole of the French section of the House is in favour of it, and the public feeling is generally so strong, that the Government see it cannot be resisted, and will, it is believed, most wisely give way and allow the manufacture to be free, until, at all events, the revenue becomes seriously affected by the lessening of imported sugar, a thing which cannot be expected to happen within the next ten years.

One of the arguments made use of against the resolutions was, that there was no necessity for them, that the manufacture of beet sugar could not be expected to become, for some time, more important than maple sugar, which is quite free, and, although strictly a domestic manufacture, is produced in the aggregate in large quantities. Not only do some families, favourably situated, use it altogether, but large quantities are for sale. It is a "pet manufacture," and takes place when there is little else to do on the farm; and it is so favourite a condiment with the public, that it sells as an article of luxury, at a higher price than the best cane sugar. Everybody is fond of it. It is melted down with water into molasses and used for sweetening breakfast and other cakes, such as buckwheat cakes, Johnny cakes, and a hundred other preparations, which originated with the early settlers, when good bread was difficult to be had, and when substitutes were a necessity, and those substitutes have now grown into a luxury. For these purposes "maple molasses" are considered far superior to the best golden syrup and other sugar-house productions, and are valued accordingly. It will thus be seen that domestic sugar, prepared "free of duty," is no new idea to the Canadian mind, and as beet root sugar must always be refined by capitalists, and in large quantities, the collection of duties, when the revenue shall be affected by the increase of production, will be an easy matter.

The proposers of the resolutions, in answer to the "maple sugar argument," stated, that beet sugar necessitated the outlay of a large capital, whereas the manufacture of maple sugar requires no capital of any consequence, and that capitalists could not be expected to invest their funds in a new industry, the chances of which are always, in the first place, *against* the manufacturer, unless there was such a balance in their favour, in the way of incidental protection, as to counterbalance the losses and disappointments which are always expected by prudent people when establishing a new business.

Amongst the information on beet sugar which has been published in Canada, is a little pamphlet on the subject noticed in our review of new works, which has been extensively circulated, and which has been carefully prepared by the author in such a way as to popularise the subject, and to bring it before the unscientific reader so that any person of ordinary intelligence can understand it, and in which chemical terms and scientific nomenclature, as far as possible, is banished, so that any one who wishes to get a reasonable knowledge of beet sugar, can acquire that knowledge without the difficulties of struggling against terms which, although perfectly easy to understand by the scientific reader, at once act as a stop to those who are not acquainted with such terms.

The turning point of beet root sugar must always be the carriage or haulage of the roots. Beet root consists of about 80 per cent. of water, and we cannot afford to carry about water for more than a very short distance. This difficulty has been met in France and Germany by the establishment of "*Raperies*" on the outside rounds of the beet growing territory, and in these "*Raperies*" the root is reduced, and the juice is conducted to the factories by iron pipes, through which the juice is forced often for a distance of several miles. The Shutzenbach method in Silesia admits of the use of dried roots, the roots when sliced and dried become portable, and still yield their sugar without difficulty.

When beetroots are cut up and dried, they are about equal weight for weight in value to barley, and can, of course, be carried as far as that grain can. It will thus be seen that the root must be reduced in bulk, for the purposes of carriage, in one of three ways, viz.,

1st. The juice must be defecated and reduced into "concrete" in the way pointed out in the before-mentioned pamphlet.

2nd. Or, it must be dessicated and dried.

3rd. Or, it must be ground and pressed at the *Raperies*, and the juice conveyed in iron pipes from the outlying plantations of the root to the factory.

For all practical Canadian purposes, these plans are reduced to the concentration of the juice into concrete, and the drying of the roots,—for the pipeage scheme is totally inadmissible in Canada,—

the roots to be profitably raised for the country must be raised at great distances from centres, and conveyed to market as other farm produce is conveyed.

Eventually, the two plans will be about equally worked. By farmers of greater intelligence the juice will be prepared and boiled down; by farmers, who cannot manage this process, the root will be cut up, dessicated and dried, and brought to market in that state.

There is another point in this question of beet sugar which must, on no account, be lost sight of—namely, the manufacture must be so conducted as to benefit the land, as well as benefit the immediate funds of the farmer; for, if this be neglected, those who neglect it will, in the end, assuredly come to grief.

The cultivation of beetroot, like the cultivation of all other root crops, greatly benefits the land, *provided* the refuse matter be returned to the soil. The cultivation of the root must be good, and well done, or the produce of the crop will be unsatisfactory.

By the plan of reducing the juice to concrete on the farm, or within such a distance of it that the refuse can be returned to the land, the farm will be continually benefited by the increased quantity of manure obtained; and the only thing which is withdrawn from the soil are "the salines," which it is the object of the refiner to remove from the sugar. These salines consist chiefly of potash and soda; and, in Canada at all events, can be easily replaced from the destruction of the forests and other sources of potash, or the salines can be brought back in a crude state from the refinery and returned to the soil with the manure.

But, with the "dried root" plan, the whole of the crop, except the leaves of the plant, will be carried off the farm, and the consequence will be deterioration, instead of benefit, to the land. Nevertheless, there will always be found persons who are so careless and thoughtless of the future, that this consideration will be neglected; and, therefore, those who go into the manufacture of beetroot sugar must be prepared not only to refine the concrete, but to extract the sugar from the dried roots.

The question of beet sugar has progressed in the United States in even a greater degree than in Canada. As far back as 1865 and 1866, the United States Government sent a deputation of "*savans*" to Europe to learn all that could be learned upon the subject, and their report, with much other valuable information, is embodied in the "Reports of the Department of Agriculture," published by order of Congress, for the years 1867 and 1868. The subject is also taken up in the Agricultural Colleges of the United States, particularly the Agricultural College of Massachussetts, in which Dr. Goesmann is professor: that gentleman has published in the *American Chemist* some very valuable papers on the subject. There are some three or four beet sugar factories, of large capacity, now working in the United States, the largest of which is in California, so that the manufacture of beet sugar may now be considered as fairly transplanted to the American continent, and it only awaits the natural growth which a profitable enterprise is sure of, to add another blow to the production of slave-grown cane sugar, and to transfer the sugar industry from the tropics to the temperate regions of the world.

E. L. C.

*Toronto, Canada*, 1873.

## ON THE EFFECT OF SULPHUROUS ACID UPON SOLUTIONS OF SUGAR.

By Alfred Fryer.

Each few years witnesses the rediscovery of the application of sulphurous acid as a bleaching agent for solutions of sugar, and it would seem that each sanguine inventor fails to make himself acquainted with the reasons which have led to its having been discarded.

Sulphurous acid is not free from the dangerous power of producing inverse sugar under the influence of heat, and though this power is a comparatively feeble one, it is accompanied by the fatal one of becoming converted into sulphuric acid. This acid, as is well known, effects the destruction of cane sugar with singular rapidity.

The planter may improve the tint of his muscovado sugar, but he will learn in time that nearly the whole of his sulphur bloom will have passed away when his samples become exposed for sale in Mincing Lane, but the clamminess, the sure indication of inverse sugar, will have increased the drainage on the voyage, and will cause the sugar to bring a lower price.

European refiners who have used free sulphurous acid, have found their copper vessels and pipes become injured, and what is of much greater consequence, have found their animal charcoal become injured by the conversion of the carbonate of lime into sulphate of lime. Many refiners are averse to purchasing sugars that have been made with bisulphite of lime, and certainly not one would knowingly purchase those that have been made from juice treated with free sulphurous acid.

The following experiments are sufficiently suggestive:

Experiment 1.—Sulphurous acid was prepared by boiling sulphuric acid and charcoal, and the fumes washed by passing them through water. As much solution of $SO_2$ as was equal to 1 lb. sulphur to 1 ton of sugar, was added to 200 c.c. of liquor filtered through animal charcoal 32° B. cold. Notwithstanding the washing, the solution contained an unknown quantity of $SO_3$.

| | Percentage of sulphur remaining as Sulphurous acid. | Proportion of glucose to total sugar per cent. |
|---|---|---|
| Before being mixed .............. | 100 | 7·3 |
| Immediately after being mixed—cold | 92 | — |
| 1½ hours after being mixed ........ | 60 | — |
| 4 ,, ,, ........ | 60 | — |
| 2 days ,, ,, ........ | 41 | 7·5 |
| Concentrated in evaporating basin immediately after mixing, to about 40° B., and 70° Faht. Time occupied in concentrating, 1 hour .. | — | 10·4 |
| Concentrated under similar conditions, 1 day after mixing ...... | — | 11·7 |

Experiment 2.—$SO_2$ prepared as before, but the process of washing was conducted with special precautions for the arrest of the $SO_3$.

| | Percentage of sulphur remaining as Sulphurous acid. | | Proportion of glucose to total sugar per cent. |
|---|---|---|---|
| Before being mixed .............. | 100 | ...... | 9·8 |
| Immediately after being mixed .... | 87 | ...... | — |
| 1½ hours after being mixed ........ | 70 | ...... | — |
| 4 ,, ,, ........ | 66 | ...... | — |
| 2 days ,, ,, ........ | 66 | ...... | — |
| Brought to boiling point in 5 minutes after being mixed ............ | 70 | ...... | — |
| Concentrated to about 40° B., in 25 minutes .................... | 31 | ...... | 10·5 |
| Concentrated 1 day after being mixed | — | ...... | 10·5 |

EXPERIMENT 3.—When liquor to which $SO_2$ has been added is concentrated, a portion of the acid is driven off by boiling, a further portion is converted into $SO_3$, and the remainder is found unchanged in the concentrated liquor. In order to estimate the proportions of these, sulphurous acid equal to one pound of sulphur to one ton of sugar was added to filtered liquor 32° B. cold, and this was concentrated to 40° B. cold in twenty-five minutes. It was analyzed with the following result :—

| | | |
|---|---|---|
| Sulphur found as $SO_2$.............. | 31 | parts. |
| Sulphur found as $SO_3$.............. | 44 | ,, |
| Sulphur lost as $SO_2$................ | 25 | ,, |
| Sulphur originally added as $SO_2$ .... | 100 | ,, |

One pound of sulphur converted into any sulphur acid, and added to one ton of sugar, will require 1·75 lbs. caustic lime to render it neutral, or 78 lbs. per 100,000.

In my paper "On the Use of Lime," (*Sugar Cane*, vol. ii., pp. 629 and 662) the effect of the $SO_3$ in the formation of inverse sugar has been shown, and from the experiments there described, it may be noted that the effect of the acid increases very much with its degree of concentration.

EXPERIMENT 3.—Solution of sugar 31° B. at 70° filtered through animal charcoal, with sulphurous acid added and concentrated in evaporating basin, except the last sample, which was concentrated in a retort in order to lessen access to the air, and in this instance, the acid was added during concentration. The amount of acid is reckoned as pounds of sulphur to the ton of sugar.

| When Concentrated. | Proportion of $SO_2$. | Proportion of glucose to total sugar. | Increase of glucose. | Colour. | Extent of Concentration. |
|---|---|---|---|---|---|
| Immediately .... | None | 7·25 | | 70 | Rather heavier than thick treacle |
| Immediately after mixing........ | 1 | 9·6 | 2·35 | 50 | Equal to masse cuite from lowest syrups |
| One day after mixing ...... | 1 | 8·7 | 1·45 | 35 | Equal to molasses |
| Immediately after mixing ...... | ·25 | 7·7 | ·45 | 45 | Equal to thick golden syrup |
| One day after mixing........ | ·25 | 7·6 | ·35 | 50 | Equal to golden syrup |
| Immediately after mixing ...... | ·5 | 7·4 | ·14 | 100 | Almost solid |

Experiment 4.—The samples were analysed in order to ascertain the amount of $SO_2$ remaining. The results were :—

| Lbs. S added as $SO_2$ to the ton of sugar. | Per centage remaining immediately after mixing. | Concentrated immediately after mixing and examined after 24 hours. | Concentrated 24 hours after mixing. |
|---|---|---|---|
| 1 | 63 | 0* | 19 |
| ·5 | .. | 17† | .. |
| .25 | 38 | 0 | 0 |

## ON THE CONVERSION OF STARCH INTO SUGAR IN THE HUMAN BODY.

If any kind of grain, or indeed the stems or roots of any plant, be brought into a state of pulp, well washed with water and strained, there will be found in the strainer nothing but a little torn cellular tissue, the greater body of the substance having passed through with the water. On examining the liquid which has thus been separated from the solid matter, it will be found that after a time a soft, white, insoluble powder will have separated out and settled at the bottom of the vessel in which the liquid is contained, whilst the upper part of the solution remains perfectly clear. If, now, the water be decanted and the remaining powder dried at a very gentle heat, it is found that the precipitate is, to all appearance, an amorphous body, but on examination with the microscope this is found not to be the case, but that it bears a complex structure. If an orange be skinned in such a manner that, beginning at one of the flattened ends, the skin be removed by cutting round and round until it is detached in one continuous whole, we find that if the skin be allowed to resume its natural position, it appears, when looked at end-ways, to be built up of rings having a common centre: this then is the appearance presented when the powder is examined microscopically. It is composed of numerous small bodies *ringed* in the manner just described, each having a small black central point called the "hilus." Moreover, these small bodies are each enveloped in a bag of membrane, and are the granules of the well-known substance, starch. When this starch, which we have seen can be obtained from any grain or vegetable, is mixed with water and heated to about 200° Faht., or nearly the boiling point of water, these small bags burst and, mingling with the water, present an appearance with which all are familiar, gelatinous starch, whilst the membrane, of which the bag was composed, remains suspended in the solution, and to this the liquid owes its beautiful opalescent appearance. The starch is now in that condition in which it is used for stiffening linen, &c.

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* More highly concentrated than that which stood 24 hours previously to being concentrated.

† This sample was examined shortly after concentration in a retort.

If a little of the starch, in this gelatinous condition, be boiled with a small quantity of sulphuric acid, another change takes place. It loses its pasty consistency, becomes clear and limpid, and on evaporation a brown gum-like substance is the result, to which has been given the name *dextrine*, and is in reality that substance which is known in commerce as *British gum*. But if instead of stopping when this dextrine is obtained, the boiling with sulphuric acid be still further continued, the change which the starch is undergoing proceeds, until after a time the gelatinous starch which was put into the vessel, and which presented no appearance of crystallization, becomes converted into a thin syrup-like substance, which, if allowed to remain for some time, deposits crystals of a body called glucose—one of the many varieties of sugar.

But this boiling with acid is a long and tedious process, and if it be required to convert starch into sugar some much more rapid method must be employed.

When barley is steeped in water and then exposed to an elevated temperature a change takes place in its constitution—the grains begin to germinate and if when this germination has proceeded far enough, it be checked by drying in kilns, the barley arrives at the condition known as malt :—moreover if this malt be crushed, infused in water, left to stand an hour or two and the clear liquid then boiled with hops, we have produced the well known beverage beer. If then to some of the gelatinous starch previously mentioned a little of this substance—malt—be added, and kept in a warm room, it very soon begins to liquify, and becomes comparatively clear. A great change has taken place. If it were to be tasted it would be found that instead of the peculiar taste belonging to starch, it would possess the much more palateable one, of sugar, and, if submitted to analysis, the solution would be found to contain a very small trace of dextrine—British gum—and a great deal of the other body, glucose—sugar,—whilst the starch originally present in the liquid had completely disappeared.

The question now arises, what property is it that the malt possesses which enables it to be the medium by which this conversion is produced? Malt, as has been shown, is merely barley which has been allowed to germinate slightly, and after germination had reached a certain point, it had been suddenly stopped by the application of heat. During germination the starch, which, as has been said, is present in all grain, undergoes a species of fermentation, and the same effect takes place in the seed as has been already stated to occur when malt is added to gelatinous starch; that is to say, it becomes converted into a mixture of dextrine and glucose, and these substances are assimilated by the young shoot, which is the product of the germination. This change in the seed-starch is occasioned by means of a peculiar ferment called *diastase*, of which little can be told, as up to the present time the minds of scientific men are still vexed upon this point. Dubrunfaut has given to a ferment which he considers to be the same as *diastase*, and which he procured from malt, the name *maltin*. When the malt is added to the gelatinous starch solution, it carries along with it some of this diastase or maltin, which, as the germination of the seed was checked, was not used for the conversion of the starch in the seed, so that it is now ready to commence the conversion of any starch to which it may be added, into the two substances, dextrine and glucose.

But the above mentioned facts have a deeper bearing than that belonging to the mere conversion of starch into sugar, as done in a laboratory; they possess a deeper interest than the interest attaching to a chemical change. Their action occurs daily and hourly in the human body, and it is to this view of the change to which I wish to direct attention. To understand more fully the manner in which this change affects our life, I must direct attention, in as few words as possible, to the nature of the digestive apparatus in the human body.

After the food has been well masticated by the teeth in the mouth, and thus mixed with saliva, it passes by means of a tube called the *Aesophagus*, to a large pouch, bearing some resemblance in shape to a pear—the stomach. Here the food comes in contact with another fluid—the use of which will be examined shortly—called the *gastric juice*, after being exposed to the action of this juice for a sufficient length of time, it passes by means of a gateway called the *Pylorus*, into the tube called the *Duodenum*, from thence it undergoes a series of changes in another tube, which, however, differs from the *Duodenum* in being convoluted, and which is called the *Jejunum*, and from this it is sent into another tube called the *Ileum*.

If, now, the general foods which are consumed at dinner be considered, it will be found that nearly all of them contain a large percentage of starch. The food when being masticated is being brought into a state of pulp, from which the soluble substance, starch, is after a change assimilated by the body, whilst the insoluble matter, or matter of no value as nutriment, is excreted. It is the changes which the starch undergoes in various parts of the body which I now propose to follow out as minutely as I can. I wish to show its use as a constituent of human food; how it goes to repair wasted energy; how it passes into the blood, and acts as a builder up of the human frame. The food, when undergoing mastication, is brought into a state of pulp by admixture with the saliva.

The first question with which we have to deal is, whether or no saliva exerts any action *per se* upon the starch which is present in the food? To come to a conclusion on this point, it is necessary to know the composition of saliva. Of this substance no very exact, *satisfactory*, analysis has been made. Its specific gravity in man varies from

Specific gravity (man) ......1·0031 to 1·0043.
Solid residue ,, ...... 0·571 to 0·616.

Bidder and Schmidt found in the saliva of the dog, in 1,000 parts,

Water 995·3

| | | |
|---|---|---|
| Solids. 4·7 | Organic Matter 1·4 | |
| | Salts ........ 3·3 | Potassic & Sodic Chlorides 2·1 |
| | | Calcic Carbonate ........ 1·2 |
| | 4·7 | 3·3 |

The minute composition of saliva is a vexed point. Observers go a certain length together and then branch off into somewhat ideal suppositions. Miahle believed that he had actually discovered in the saliva a substance, to which he gave the name salivary diastase. Other observers, such as Wright, Magendie, Bernard, and Jacubowitsch, experimenting on the saliva of animals other than man, came to a similar conclusion; but although the fact stands, that there is in saliva a substance which, seemingly, acts in a manner similar to diastase, the name by which that substance is known, is indifferently ptyalin, diastase, or maltin.

If starch and saliva be mixed together, it requires from ten to fifteen minutes before any appearance of sugar is discovered, so that, taking this strange fact into account, we come to two conclusions, first, that saliva has the same action upon starch, although requiring longer time to cause it, as diastase has, and, secondly, considering the length of time required for the saliva to act upon starch, it is evident that either the starch cannot be converted completely into sugar in the body,—a very unlikely fact—or that one of the other juices of the body has a similar action upon it. Saliva, however, acts as a medium for bringing the food which is being masticated, into a condition suitable for being acted upon by the other juices; having thus both a mechanical and chemical effect.

It may be useful to observe that the action of saliva on boiled starchy matter, is much more rapid than when the starch is presented to it in a raw condition, boiled starch being almost instantaneously converted into dextrine and sugar.

*(To be continued.)*

## CONCERNING SUGAR DETERIORATION.

By Edmund A. Cook, Ph.D., F.C.S.

It is well known that cargoes of sugar arriving in this country from the tropics do not all reach their destination in the same condition, or of the same quality, as the shipper thought probable. The samples sent by the manufacturer are generally better, and often several shillings better in value than the bulk turns out on arrival. This has been so often the case that purchasers of floating cargoes have sought to establish a protective system, by which they shall obtain some guarantee of a similarity between sample and bulk, or a compensation for its absence. There have not been wanting suspicions that fraud and unfair dealing have been perpetrated in the interest of the seller; of course it cannot be doubted that the substitution of a sample of a quality which is really superior to the bulk of which it is pretended to be a portion can be nothing but a swindle, and whether such fraud were practised by the *fabricant* or his agent would not alter the fact. The manufacturer is forced to admit that the sample he presents, and by which he sells his product, often bears no resemblance to the bulk on its arrival, but he asserts that when shipped the sugar was similar to sample, and that it has undergone deterioration during the voyage: that is to say, that a voyage of from thirty to forty days duration, from a hot climate to Britain, is often sufficient to alter the character, and even the crystalline appearance of a cargo of sugar, causing a loss of colour, and increasing the per centage of grape sugar at the expense of the cane. At first glance this assertion seems so improbable that it meets with no credence, but before rejecting it altogether, it is perhaps well to examine the possibilities of such a change, and to bear in mind that if no such alteration is possible, more than nine-tenths of the growers or makers of sugar must be guilty of gross fraud; moreover, if such change does take place, it must be greatly to the interest of planters that its cause should be ascertained, and a remedy applied, if such remedy exists.

It is generally taken for granted that any change which a cargo of sugar undergoes in transmission, must be a change for the better, as it is due to a drainage of molasses, and the sugar must be better for all loss of weight from such a cause, but I think these are sufficient facts to prove that a different change may and often does take place. An exceedingly singular case of deterioration came under my notice last autumn, and it was one in which every ordinary precaution had been taken to avoid change. A Tobago planter manufactured some fifteen hogsheads of fine sugar, and shipped them for Britain. At the same time he shipped, by the same vessel, a small barrel to be presented to a friend; the barrel was placed in the cabin. Being in bad health he came home himself, and brought the samples with him.

On the arrival of the sugar it was found to bear no resemblance to the sample brought by himself, it had deteriorated to the extent of about 2s. 6d. in value, but the small barrel in the cabin had remained unimpaired. It is perhaps easy to understand how a small barrel of sugar standing by itself would soon lose moisture, and the dry sugar be unchanged by the thirty days' voyage, but the fact that this barrel was of superior quality to any of the fifteen hogsheads tends in a small measure to corroborate the planter's statement with regard to the original quality of his sugar. Another fact communicated to me regarding the sugar seemed of importance. The planter had taken a small quantity from one of the centrifugal machines and filled a small pill box with it, this he had enclosed in another pill box and placed them on his office desk, his office being situated about 200 yards from the machine house. In about nine days, on opening the boxes he found instead of a box full of sugar, a very small heap of it, and both boxes saturated with moisture. It naturally occurred to me that some deliquescent salt might have been present, but neither the shipping nor the landing samples bore out this idea, and the shipping and landing weights were nearly identical, there had been no drainage. Both samples were however faintly acid, but so faintly that in order to detect it a small pill of each was made on neutral litmus paper and moistened with a drop of pure distilled water, which on reaching the paper gave a red colour.

It seemed to me reasonable to admit that, in this especial case, deterioration had certainly occurred; and if it is possible in one case, there can be no doubt it is possible in many. It is important, therefore, to ascertain the cause and the remedy for it.

If we take some small grained crystals of proto-chloride of iron, and place them, slightly damp, in a test tube, and tightly cork it when full, the opaque closely coherent mass will remain unaltered while kept at one constant temperature. But if the tube be kept in a room in which a fire is burning during the day, or in which the temperature varies within a range of less than 30° Faht., very few days will suffice to produce a marked alteration in the contents of the tube. The opaque mass will become transparent, the grainy crystals will disappear, and in their place will be seen large clear crystals of the compound. If some phosphate of quinine be precipitated from a strong solution, it will fall as an apparently amorphous mass; but a few days' standing, under similar variations of temperature as in the preceding experiment, will convert the amorphous mass into needle-like crystals of considerable size.

The above two simple experiments will suffice to lead up to the idea that comparatively slight variations of temperature may effect a considerable change in sugar crystals also. But inasmuch as chemical change of some sort may take place at the same time, in the case of sugar, it is not probable that small crystals will be dissolved and large ones deposited, but rather the reverse. The facts must be noted that the temperature during the sugar season in the tropics averages 90° Faht. in shade during the day, and often falls to 50° Faht. at night, that the atmosphere is necessarily heavily charged with moisture, a good deal of which is deposited with the decrease of temperature, and, that the packed sugar contains, at least, 2 to 3 per cent. of water. If it can be allowed that the temperature of the interior of the casks varies with the varying outer temperature, here is at once a possible cause of deterioration; and, if only the outer rind of the hogshead of sugar was affected in temperature, a rise of from 50° to 90° Faht. would dissolve, and a fall to a similar extent would cause a re-deposit of sugar; and this proceeding, day by day, might produce a very appreciable effect in short time. This idea will receive some support from the fact that clayed Havannas, exported dry, generally equal shipping sample in quality.

In order to obtain, if possible, experimental proof of the possibility of change taking place in cooled sugar placed under temperatures varying from 90° Faht. to 50° Faht., some Porto Rico sugar, of similar quality to the Tobago samples, and also some beet, was placed in separate flasks, and tightly corked. For 10 consecutive days the flasks thus prepared were exposed to a temperature of 90° Faht., and during the night were kept at about 50° Faht. The result was a marked change in the appearance of the sugar, and an increase of grape at the expense of the cane, and this before the expiry of the 10 days. Some sugar under similar conditions, but kept day and night at 90° Faht., changed but little. What may be, perhaps, termed an accidental experiment was tried. At a lecture to an audience of about 300 people, in a badly ventilated room, some refined crystals, containing about 2 per cent. grape, and a little water exhibited for about one hour. After the lecture, the sugar was poured into a stoppered bottle and left in the same room, forgotten for about a week; during which time about three similar meetings were held there, the normal temperature being about 40° Faht. When the bottle was thought of, and examined, instead of pretty clear crystals, there was a claggy mess by no means pretty, and very moist. The mess was, unfortunately, not examined chemically. On further thought over this result, the experiment was tried of leaving some light-coloured colonial sugar exposed with water, under cover, so that it should constantly be in an atmosphere saturated with moisture, whatever the temperature. The temperature of the room during the experiment did not vary more than a few degrees, and not much difference was observed in the sugar. But when a few drops of ammonia were added to the basin of water, the colour of the sugar deepened in a single day, and very soon changed its character entirely. From this it can be gathered, that sugar containing moisture, exposed to varying temperatures, will deteriorate, and it will deteriorate much more quickly, and to a far greater extent, if ammoniacal fumes be also present. The old-fashioned mode of valuing sugars for sale, by colour and appearance, may easily be proved fallacious. A sample of sugar may be taken of high standard and exposed for a few moments to the fumes from a bottle containing ammonia. Immediately, a darkening in colour will be observed, and to such an extent that high-class sugars will present an appearance many numbers lower. This darkening is permanent, and might be an exceedingly easy method for the use of continental *fabricants*, whereby sugar of good quality may be made to pass as inferior.

It must be remembered that there is another possible cause of deterioration of sugar, a cause which sometimes even attacks British refineries, and the effects of which are graphically known as "the devil in the house," and more technically as "smear." The exciting cause is undoubtedly a species of ferment, the most favourable conditions for the development of which have not been very exactly studied, but a low temperature is not inimical to its operations on a large scale, and no doubt ammoniacal fumes will favour its increase.

Whether the deterioration of sugars after manufacture and during transit is due to any one or to all of the above causes may be matter of opinion, but it is a fact that dry sugars are admitted not to deteriorate, and these are the sugars upon which either aqueous vapour, ammonia, or ferment would have least effect, hence it appears probable that if effectual drying before packing did not cause a total disappearance of the evil, it would diminish it in a marked manner.

## STATEMENT OF THE REASONS

*For the "Projet de loi" laid before the séance of the Chamber of Representatives of the 28th November, 1871.*

By M. Jacobs, Minister of Finance.

### Duty on Sugars.

For some years the manufacture of beetroot sugar has been greater in Belgium than in any other country.

Up to the year 1850, the number of manufactories scarcely reached twenty or thirty; in 1860, the number was sixty-five; during the ten following years, there have been 69, 74, 79, 84, 100, 106, 104, 107, 115, 131, the actual season of 1871-72 saw 150 factories at work, and the opening of 18 new manufactories for the next season is announced. Let us add to this, that the most of the new factories are so important that the progression of the amount produced is sensibly in excess of that of the number of manufactories. That is, the estimated production before 1850, was from three to four million kilogrammes (3,000 to 4,000 tons); in 1860, more than seventeen million kilogrammes (16,733 tons); and during the ten following years successively, 16, 19, 26, 20, 27, 42, 39, 25, 40, and 48 millions (15,000 to 47,000 tons).

This will most probably reach in the present season, 60 million kilogrammes (about 60,000 tons).

The following table will show how this movement involves with itself that of France and Zollverein :—

| Years. | Belgium. | | France. | | Zollverein. | |
|---|---|---|---|---|---|---|
| | No. of Manufactories | Estimated Production. | No. of Manufactories | Estimated Production. | No. of Manufactories | Estimated Production. |
| 1850 | 28 | 5,800,000<br>5,709 tons | 290 | 67,000,000<br>65,947 tons | 184 | 45,000,000<br>44,293 tons |
| 1860 | 65 | 17,000,000<br>16,733 tons | 341 | 108,000,000<br>106,303 tns | 247 | 145,000,000<br>142,722 tns |
| 1870 | 131 | 48,000,000<br>47,246 tons | 458 | 210,000,000<br>206,701 tns | 284 | 215,000,000<br>211,622 tns |

Thus, whilst in France the manufacture has only increased in the ratio of one to three, in Zollverein of one to five, the ratio in Belgium is more than one to eight.

As to Pays-Bas, the manufacture of beet sugar is quite recent, and is taken up by only twenty-five factories. In England it is limited as yet to experiments, the results of which are doubtful.

There is certainly reason for congratulation on such a rapid progress of a manufacture which is bound closely to agriculture, and to numerous industries of which it employs the products ; it is necessary, however, for the general interests of a country, and for those of the manufacturers themselves, to enquire whether this soaring be not merely the natural result of economy of labour, or whether it be due in part to some of those artificial causes which create a transient prosperity leading to a crisis, ofttimes to disaster.

Before the application of the results of the experiences of 1865, in virtue of the Convention of November 8th, 1864, to the exportation of refined sugar, the sums absorbed each year by the bounty on exportation were divided between raw sugar and refined sugar. But as a result of these experiments, the produce has been carried to a height so elevated, as to exclude all idea of a surplus in refining. The decadence of this latter industry proves sufficiently that it is not in the enjoyment of exaggerated advantages, the average of the annual exportations of refined sugar, which, during the period 1850-1860, exceeded 20,000,000 kilogrs. (20,000 tons), fell to less than 14,500,000 kilogrs. (14,000 tons), during the ten following years. On the other hand, foreign refined sugars have come to take away the custom of the interior in indigenous refined sugars; the duties on sugars imported are raised:—

| | Francs. | £ | |
|---|---|---|---|
| In 1865 | to 110,551 | 4,600 | about. |
| ,, 1866 | to 212,616 | 8,800 | ,, |
| ,, 1867 | to 448,810 | 18,700 | ,, |
| ,, 1868 | to 605,651 | 29,400 | ,, |
| ., 1859 | to 974,790 | 40,600 | ,, |
| ,, 1870 | to 989,185 | 41,200 | ,, |
| ,, 1871 | to 1,479,355 | 61,600 | ,, |

In the actual condition of the legislation and the production, it must be acknowledged that the manufacture of raw sugar produces some wondrous benefits. It is one of the causes of that unexampled prosperity of which we have previously spoken.

For conviction's sake it is necessary to render first an exact account of the legislation which regulates the Excise, and I shall then resume in a few words the fundamental arrangements.

The duty is collected in Belgium on a charge based on a kind of legal presumption; the manufacturer does not pay in a ratio to the amount of sugar *really* manufactured (the administration does not ascertain these things) but in a ratio to the *presumed* production, in sugar, of the juice of the beet-root submitted to purification; the quantity and the density of this juice, the raw material of sugar, are alone ascertained; it thus happens that the whole of the sugar obtained by the manufacturer beyond the production is free from duty. This would be but a small evil if the produce went to increase the interior consumption, since the quantity consumed free from duty would always nearly represent the same proportion to the quantity manufactured, and that in the upshot, the quantities submitted to duty would follow very nearly the movement of consumption. But the position becomes complicated by reason of the exportation of raw sugar, the development of which increases each year and attains considerable proportions. Or as is allowed to the manufacturer who exports the sugars the exoneration from duty which he would have to pay if the legal presumption or charge had not left him an overplus, and not that of the duty really paid by him, in taking count of the overplus obtained, it thus happens that the more he exports the more overplus there remains in the country free from duty; whilst this overplus is sufficient for our consumption, sugar will bring next to nothing to the Treasury.

Let us take, for example, a manufacture of 25,000,000 kilogrs. (about 25,000 tons), of which 15,000,000 kilogrs. (about 15,000 tons) were exported, and let us suppose an overplus of 10 per cent. on the legal production; there would remain for consumption an apparent amount of 10,000,000 kilogrs. (about 10,000 tons); but in reality we would have consumed 12,500,000 kilogrs. (about 12,000 tons), because it is necessary to add the overplus of 10 per cent. on all the manufacture. This thus raises it to 50,000,000 kilogrs. (about 50,000 tons), and the exportation would be carried to 40,000,000 kilogrs. (about 40,000 tons), the apparent consumption, that of which the statistics are composed would remain at 10,000,000; whilst in reality it had absorbed, on the other hand, 5,000,000 of overplus, and had thus reached 15,000,000 kilogrs. (about 15,000 tons).

To make certain of the fact, that the real consumption was greatly in excess of the apparent consumption, such as is shown by the sum total received, it is of use to compare the movement of the consumption in Belgium with that of the neighbouring countries. In France, the consumption has increased by 10 per cent. during the last six years; the increase has been more than 37 per cent. in Zollverein, it has attained in England the large proportion of 50 per cent.* In Pays-Bas, the considerable development of the importation of raw-cane sugar, exported in the state of refined sugar, and the modifications in the legal production, render it difficult to calculate exactly the consumption. But we may affirm that with a population not amounting to three-fourths of ours, the produce of the duty on sugars, of which the price is scarcely higher than in Belgium, is raised from 2,000,000 to 4,500,000 florins since the Convention of November 8th, 1864.

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* The duty was reduced, in 1870, from 12s. to 6s. per cwt.

Belgium alone seems to remain stationary. The average consumption during the years 1868, 1869, and 1870, is 16,072,206 kilogrs. (about 16,000 tons); or the average of the three last years of the ten years preceding 1858, 1859, and 1860, was 15,823,067 kilogrs. (about 15,000 tons), and in these numbers are not comprised 2,122,304 kilogrs. (about 2,000 tons) of syrup exported with exoneration from duty, products which are necessarily comprised in the figures of the interior consumption, since the law of 18th July, 1860, has excluded them from the benefits of the drawback.

Thus, while the consumption of sugar has everywhere increased, must it be admitted that in Belgium, which has fallen behind no country in the development of its riches, it remains about the same? The contrary is evidently the case, and the only conclusion which can be drawn from what we have shown is, that in Belgium large quantities of sugar annually escape taxation.

This acknowledged, it is the duty of Government, in spite of, or rather for the interests of refineries, not to allow their development to rest on a bounty previously deducted at the expense of the Treasury; otherwise the time, uncertain perhaps, yet near and inevitable, when the bounty will be done away with or reduced, will be marked by the closing of the refineries and the loss of the capital employed in the manufacture of sugar; the State will be considered morally responsible for the ruin.

In order to remedy this, the question is to determine by how much the real production is in excess of the amount charged legally, laid down in the proportion of 1,500 grammes (33lbs.) of sugar per hectolitre (22 gallons), and by the density of the juice to be purified.

We have at first as a guide to this valuation the amount of ascertained overplus in the manufactories situated within the custom house radius, from which no sugar can be sent out without a document. The average of this overplus amounts to nine per cent,* and the only thing that can be supposed is that the manufactories from whence they come are exceptions in the country.

Thus in Pays-Bas where the subscription is optional it is fixed at the figure of 1,635 grammes (35lbs.), and notwithstanding this twenty-four manufactories out of twenty-five prefer this method of assessment of tax, to that which only taxes them in ratio to quantity really produced. In this country the production exceeds theirs by more than 135 grammes (about five ounces), being nine per cent, the amount charged in Belgium for 1,500 grammes (33lbs.).

From these preceding facts it must be concluded that, in fixing the amount to be taxed in Belgium at 1,600 grammes (35lbs.), it only implies an increase of 6⅔ per cent: we are thus much below the reality.

There is no use in hiding that at the expiration of the International Convention of 1874 those parties contracting along with us would not consent to prolong an agreement, of which the upshot, useful to all, is to place in equilibrium the conditions of production in the four contracting countries.

In doing from from this time forth that which is reasonable, we will ward off any exaggerated claims which they will be able to bring hereafter.

But a serious objection will not fail to be made: it is brought forward every time the amount chargeable is endeavoured to be raised.

They will say that, admitting 1,600 grammes (35lbs.) to be the average production, it must be acknowledged that, if some manufacturers obtain more, others do not come up to this amount, and it would be wrong to charge these latter, by way of taxation, for an amount of sugar which is excess of their actual production. Also the *voluntary tax*, as in Holland—that is to say, the authorization for the manufacturer, on presenting his demand, to be taxed according to the quantity of ascertained sugar—would he not perhaps demand it again, as was done in 1865.

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* The average of overplus ascertained in twelve manufactories within the radius of the custom house gives a production of 1,632 grammes (about 35lbs.), being 132 more than the price actually charged for 1,500 grammes (33lbs.) for the last five seasons, comprising the season 1870-71, of which the results are not yet completely known.

Government does not think it can allow this power. In 1845, when there were only twenty-five manufactories in the country, it attempted the trial of the "*exercice*," and it found that this mode of taxation opened a way to frequent fraud; besides which, it was the subject of loud complaint on the part of the manufacturers. Government renounced it at the end of a year. But now, when numerous manufactories are erected without showing in their construction any indispensable guarantees for assuring the efficacy of the "*exercice*," they could not dream of re-establishing this *régime*, which in Holland is only granted to one manufactory, and that one of small importance.

Is that to say that no satisfaction should be accorded to manufacturers who cannot come up to the average produce? Government hopes that the system which is now laid down, and which is a kind of qualified *exercice*, will be right, and answer in a just manner the cries which, every time the assessment on production has been augmented, have been raised against the unjustness of the tax assessment among the different manufacturers.

In order to understand the application of the proposed system, a few preliminary explanations are necessary.

The charge on production, such as in operation at present, is uniform for all the manufactories, in this manner, that it is rigorously proportional to the density of the juice of the beetroot being worked. That is calculated by multiplying the number of hectolitres (one hectolitre=22 gallons) of juice by the degree of density and by 1,500 grammes (33lbs.). This system goes upon the supposition that the real richness of juice—that is to say, the amount of sugar it can produce—is proportional to the density; for example, a juice at 5° gives 25 per cent more sugar than a juice at 4°. But theory as well as practice shows that this is not so: all manufacturers know that juice at a high degree gives proportionately more sugar than one at a low degree, because the foreign elements, albumen, salts, &c., which help the sugar to give density to the juice, do not increase in the same proportion, whilst the density does increase. It is found in manufacture that, when the pure juice of the beet does not increase to more than 4°, for example, it may be because the year has been a bad one, or because the soil is exhausted, or because the quality of the beetroot leaves something to be desired, the produce in sugar is sensibly less than four-fifths of that of a juice at 5°.

This admitted, the means of re-establishing an equality between the manufacturers who employ beetroot of different richnesses naturally presents itself: it consists in fixing the amount to be charged, not according to a uniform amount, but according to an increasing amount, in the same proportion to the richness of the juice. The amount to be charged should not be proportional but progressive. It would be just also to the demands of the manufacturers who employ less rich beetroots, and to those who complain that no allowance is made in the assessment of the tax for bad years.

The difficulty is reduced to finding different co-efficients which it would be expedient to apply according to the known density. This difficulty is not insurmountable, as, if it is impossible to arrive at a mathematical exactitude, it is possible to establish a progression less rapid than that which really exists, with a certainty of sensibly ameliorating the actual *régime*: it is this which we go on to show.

It is found by experiments done with great care by specialists that from 4° to 5° the richness of the juices increases more than twenty-five grammes (about 1 ounce) for every fifth of a degree, and that from 5° to 6° the difference is a little less.* We are thus below the reality in adopting for the progressive amounts to be charged the following numbers, calculated by taking as a starting point the produce of 1,600 grammes (about 35lbs.), for the density of 105° to 105$\frac{3}{10}$° exclusive, the density of water being 100°.

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* The difference is much greater practically: in taking such low figures it is to avoid all debate and to give the assurance that when the real errors are compared they will never be in excess of these.

| | | | | |
|---|---|---|---|---|
| Below | 104·2° | ................. | | 1475 |
| ,, | 104·2° | and less than | 104·4° = | 1500 |
| ,, | 104·4° | ,, | 104·6° = | 1525 |
| ,, | 104·6° | ,, | 104·8° = | 1550 |
| ,, | 104·8° | ,, | 105° = | 1575 |
| ,, | 105° | ,, | 105·3° = | 1600 |
| ,, | 105·3° | ,, | 105·6° = | 1625 |
| ,, | 105·6° | ,, | 105·9° = | 1650 |
| ,, | 105·9° | ,, | 106·2° = | 1675 |
| ,, | 106·2° | and over.......... | | 1700 |

This tariff gives a progression greatly inferior to that which can be made. The differential tax which would be the result, without reaching entirely the amounts produced, would come very close to them, and on this account be made more exact than that which serves at present as the foundation for the tax. However, as a new system is in question, the law would only fix the principal points, leaving to Government the right of deciding the intermediate charges to the fraction of a degree. The progressive scale could then, should the necessity arise, be subsequently modified, remaining, of course, within the limits fixed by law as the beginning the middle and end of the scale (104°$\frac{2}{10}$, 105°, and 106°$\frac{2}{10}$). We would leave, however, to the demand of the manufacturer the choice of being taxed at a uniform assessment of 1,625 grammes (35lbs. about), a figure lower than the Netherland assessment.

It results from the preceding that this part of the "*projet de loi*" has principally for its object, 1st, to raise the chargeable amount from 33lbs. to 35lbs. of sugar per 22 gallons of beetroot juice, and by the degree of the densimeter; 2nd, to graduate this chargeable amount in a ratio to the height of the density, in such a manner as to take into account in the case of the manufacturer the differences of production given by beetroots, according to their quality, and according to the success of the harvest.

After raising the chargeable amount to 35lbs., the overplus being sensibly reduced, one has no need to fear seeing the receipts suddenly absorbed by the bounty in exportation. Commerce and industry will thus gain in security. Refiners and manufacturers will not be left exposed to suffer suddenly by the reduction of the assessment in delivery, by the changes in the conditions of selling to foreign lands.—*(La Sucrerie Belge.)*

## THE SUGAR DUTIES.

It is likely that ere long the Sugar Question will be again the subject of conference among the four powers, and everything that will aid us in any way should be brought forward and fearlessly discussed. We are glad to see the subject has been brought forward by the Manchester Chamber of Commerce, and that it has memorialised the Prime Minister. The following Memorial to the Right Hon. W. E. Gladstone, on the sugar duties, was adopted:—

That your memorialists have had under consideration the grievance of which the British sugar refiners complain, arising from the mode of assessing the duty on sugar according to classification in its raw state. That the French refiners succeed in obtaining a drawback on the export of sugar in excess of the equivalent of duty actually paid, and the bounty thus obtained inflicts a serious injury on the trade of British sugar refining. That whilst the bounty received by the French refiner seriously harasses the British refiner on his own ground, it does not permanently benefit the consumer. That the business of loaf-sugar refining in this country is from this cause seriously declining, and will soon undoubtedly be extinguished altogether, unless the system of international refining in bond be adopted, and the assessment of duty transferred from the raw material to the finished product in its manufactured state. That the objections hitherto made against the system of refining in bond are of a nature which present no practical difficulty; and the risk of fraud on the revenue may be easily removed. That the course which commends itself strongly to your memorialists as being consistent with sound principle, is that at the earliest period practicable the small duty now remaining on sugar should be totally abolished, which would confer a substantial benefit on the consumer. Your memorialists therefore pray that her Majesty's Government will, at the earliest practicable date, abolish the small duty now remaining on sugar, to the substantial benefit of the consumer, and that, as an immediate measure of relief, steps may be taken for holding a conference of the four Powers (parties to the Convention of 1864), with a view to the international adoption of the refining of sugar in bond, and that the duty may be levied on the finished product as it goes to the consumer.

This shows the progress that is being made, as the Manchester Chamber of Commerce is very particular as to what engages its attention. Things must come to an end soon; the question to be solved is, shall things remain as they are, or shall we have refining in bond? In condemnation of the former, we would refer our readers to the "*Exposé des Motifs*" translated on another page of our magazine, page 418.

By the time of our next issue, we hope to have something definite to announce, as having been agreed upon.

## PHENIC ACID

### As a Preventative against the ravages of the Cane Borer.

At a meeting of the Chamber of Agriculture of Basse-Terre, held at Pointe-à-Pitre, on July 1st, 1873, the President made a most interesting communication to the Chamber, on the employment, in agriculture, of phenic acid, not only as an agent for almost instantly destroying insects hurtful to plants, when brought into contact with them, but also as a means of preservation against their attacks. In examining his papers some days before, he found among them a note which he had received some years ago from M. Damour, one of the corresponding members of the Chamber, and which indicated the means to be employed in order to make it act with efficacy. This note runs as follows:—

"Employment of phenic acid for the preservation of the sugar cane from the ravages of insects which are hurtful to it." *

"By plunging the heads of the canes, before planting them, into a solution containing 1 per cent. of phenic acid, the production of the borer and other insects which are injurious to them, is prevented. Experiments have been made with great success at Viscount Turien Lagravière's plantation. The heads of the sugar canes after having been immersed for twelve hours in the phenic solution, become more vigorous, are entirely free from insects, and are a month in advance of the plants which have not been immersed.

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* Extract from the Memoirs of Dr. Béclar, entitled, *Nouvelle application de l'acide phénique en medicine et en chirurgie.* 1 vol. in 8vo.—1865, chez Delahaye, Paris.

"This remarkable result induced the Governor, ship-captain Dupré, to petition the French Government for the free entry of phenic acid into the colony (Bourbon Island)."

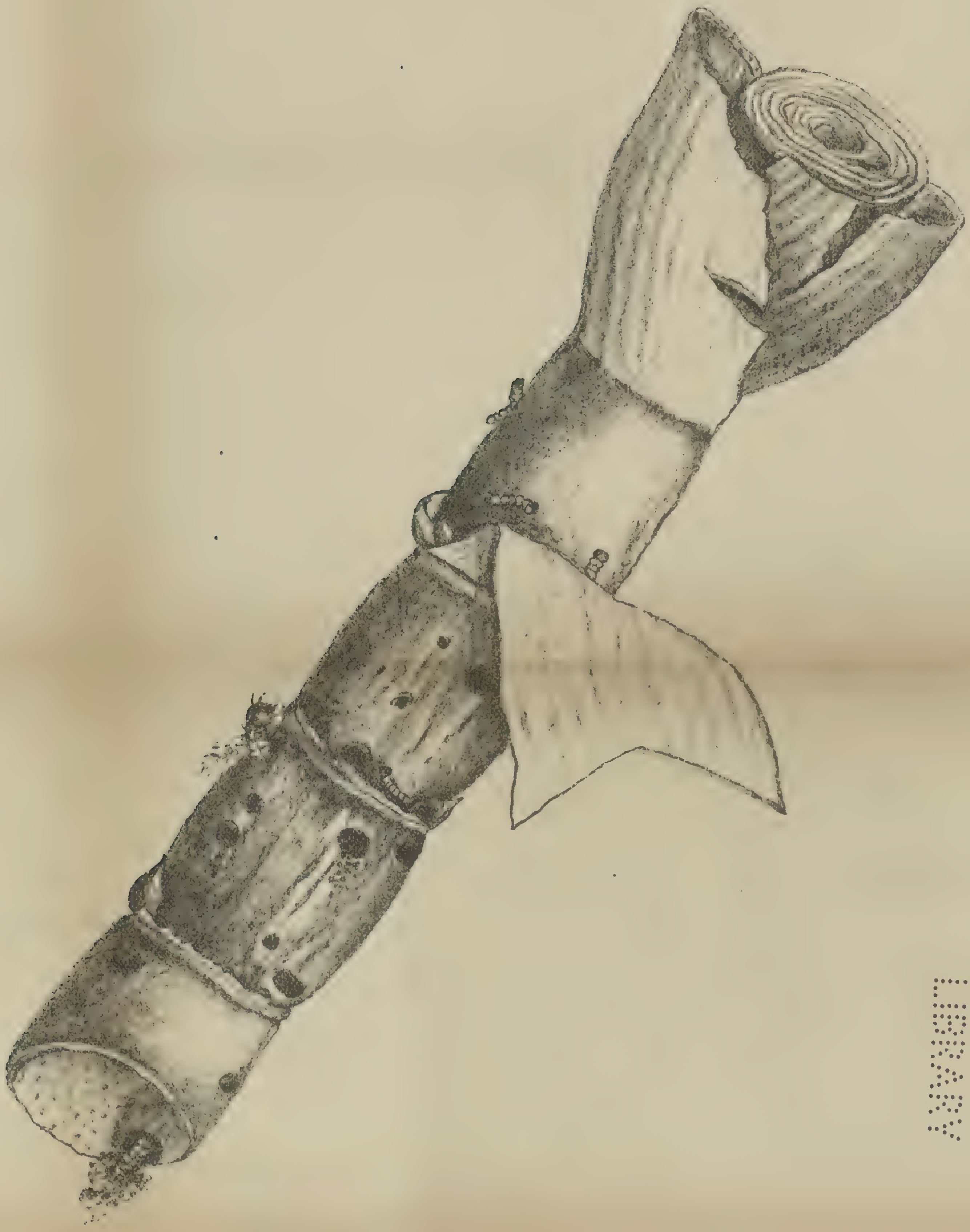
A member asked if the application of this process in Réunion had produced results which the first experiments promised?

The Secretary-Treasurer replied that an affirmative answer was given in a letter which he had recently read in a number of the *Revue du monde colonial, asiatique et américain.* At the request of the President, the Secretary-Treasurer sought for and produced to the meeting the number of the publication to which he referred; the passage which had struck the Secretary-Treasurer is to be found in a letter from Port Louis (Maurice), dated 5th November, 1864, on page 118 of the Jan. number, 1865, of the said review, and reads as follows: "The weather is dry and very favourable for manipulation; but the cane in the shore districts suffers from the ravages of the white louse and the drought: *no mention is made of the ravages of the borer, the remedy having been found.* He who complains of it must refer it entirely to his own carelessness. Let him procure what is necessary to destroy it and the white louse at the same time, which dares not attack cane treated with phenic or carbolic acid" Further, "it is necessary to tend the cane, . . . to give it fortifying baths, like those we administer to the sick: for the latter sea baths are necessary, for the former baths of carbolic acid which have succeeded so well at Maurice." Finally, the author in closing his letter says, "Carbolic acid acts as an insecticide and spur to vegetation."

To the objection raised to it on the ground that immersion of the canes in a phenic solution would be impracticable on a large scale, the President replied that what had been done at Réunion and at Maurice was not less practicable at Guadeloupe; that what could not be accomplished in one year for all the plantations in a locality, might be started first on a small scale, commencing with the portion in which the insects had committed the greatest ravages in the preceding year.

The President added that phenic acid was a sufficiently cheap product, and the expense might be still further diminished by its introduction free of duty, which would doubtless be readily obtained from the General Council.

The President reminded the Chamber that in the course of last year, the appearance in the canes, proceeding from the cane called Mia-Voï, of a worm, until then unknown in the country, had caused a certain disturbance. It was believed that the worm was no other than the borer, which has committed such ravages in the island of Réunion. The investigations of the chief naval apothecary have dispelled the anxieties to which the discovery of this little reptile had given rise. The worm in question was not the borer; but the cane has also its enemies in the colony. There exists notably in Guadeloupe, a little scarabeus known by the name of cockchafer, *(hanneton)* whose larvae, called the white worm, commits most serious ravages on the canes in certain localities, especially in young plantations. These ravages are manifested by the complete drying up of the plants. The President had seen, especially on the Saint Louis mountain, some places in which a fourth part of the plant had perished. The insect likewise exists in large quantities in Capesterre. At a certain period of the year, attracted by the light, it finds its way into the houses, alighting on the dinner tables in such great numbers that, during the meal, by throwing them into vessels of water several litres of them may be collected in an hour's time. It is more especially at the close of a prolonged drought that the insect multiplies and commits its depredations. It was with the view of combating it that the President had thought fit to bring before the Chamber the note in question, and which, as already said, had been sent to him by M. Damour.



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## NOTES FROM PORTO RICO.

Several articles have appeared in the *Sugar Cane*, and each person who has written on this subject mentions the fact that canes were most probably introduced into Europe with the knowledge of Europeans, by the Crusaders, they having found the plant in Palestine, where probably it had been brought by merchants who traded to the East, and had brought it either from the East Indies or China; presuming this to be a fact, the sugar cane would not have been known to Europeans till the twelfth century. But in contradiction to this accepted version we have the following, and to all appearance the dates are authentic.

A Spanish author, Banquieri, who, in Madrid, in 1801, published a work on Spanish agriculture, translates a Moorish manuscript written in the year 1140, by a Moor of Sevilla, Spain. This writer, Ebu-al-Arram makes an extract from another manuscript written in 1074, also by a Moor, who gives a description of the sugar cane, its mode of culture, and the method of manufacturing the sugar, then used by them in Spain.

He advises that canes should be planted on level ground near water for irrigation, that they should be highly manured, that when ripe they should be cut in short pieces, the juice expressed in a mill, and reduced to about one-fourth of its bulk in iron cauldrons mounted on a furnace, the syrup should then be well stirred to thicken it, and put in conical earthenware vases. He further mentions that the megass when fresh is excellent fodder for horses. We may readily suppose canes highly manured and passed through an indifferent mill, perhaps with barely one third of the juice extracted would make good fodder; and the Moors, who take great care of their horses, would not fail to take advantage of such a nourishing substance.

This manuscript of Ebu-al-Arram is still extant. Banquieri's work is still obtainable in Madrid, and it is strange this circumstance has escaped more general observation. The mode of cultivation recommended by the Moor is very similar to that now in vogue, viz ;—high manuring and plenty of irrigation, and does entirely for any reverence a planter may have had for Pere Labat, whose name is associated with a system which had been in practice among the Moors fully five hundred years previously to the introduction of it by him.

I may mention from my own experience, fresh megass from plant canes is excellent fodder both for horses and cattle, they feed on it willingly, and thrive wonderfully; I always feed my stock on such megass when I have it, they do not however eat the megass from dry hard canes.

Any planter who has visited the south coast of Porto Rico, and seen the difference between the luxuriance of canes grown on estates where there is a good supply of water for irrigating them, and those of neighbouring estates that may not possess the same advantage, would admit the justness of the Moor's advice. On the south coast of Porto Rico, unless in very wet weather, the river courses are dry, all the water being dammed up and taken by the neighbouring estates to irrigate their canes, if such a system was adopted by the Windward Island planters they would soon increase their crops; for instance, in the island of St. Lucia, the plain of Vieux Fort, almost out of cultivation owing to the prolonged drought, is intersected by a river; this water is merely used to work two paltry mills; if by canals judiciously arranged, each planter having a right to it, or a portion of it, during a certain number of days monthly, the whole of what now runs down uselessly to the sea were applied judiciously to the plants, that district alone might produce more sugar yearly than the whole island does now.

In the Carib county and other dry districts in St. Vincents, were the water, which is now used to move the mills, spread through their cane pieces, they would produce double the crops.

## THE CANE BORER IN THE MAURITIUS.

The accompanying plate represents the summit of a Belouguet cane, perforated in many parts by caterpillars (Borers,) as well as young caterpillars lodged between the leaves, and which have not yet introduced themselves into the interior of the cane.

## ON IRRIGATION.

(*Continued from page* 357.)

If we turn to Spain, we shall find a much more economical distribution of water. The Arabs originated most extensive irrigation works in that country, watering the land most assiduously wherever it was practicable, by means of canals and subterranean tunnels. Many of their works have been in working order for upwards of 1000 years.

The best engineers in Spain consider that a cubic foot per second should never be made to irrigate less than 140 acres, whilst, in Granada, where the rainfall is 33 inches, it irrigates, as we have seen, 244 acres. In Lombardy and Piedmont the rainfall is from 37 to 38 inches, and yet the cubic foot irrigates only 120 acres. The largest amount of water given at any one irrigation in Spain is 9,884 cubic feet per acre, equal to 2·7 inches of rainfall, whilst the more usual amount is 7,060 cubic feet per acre, or 1·9 inches.

In Spain the cereals receive two or three waterings, according to circumstances, at general intervals of a month; potatoes, and such crops, every three weeks. In India three to eight waterings per annum are given, according to crop; for example, sugar is allowed four waterings per crop. Supposing the dotation to be 10,000 cubic feet per acre, the total supply of water to the sugar crop would be equal to 11·2 inches of rain. In North India there is frequently an interval of 50 days between each irrigation.

In order to irrigate properly, the supply of water must be drawn from a higher level, passed over or through the soil, and the surplus drawn off at a lower level. It may be led from a part of the stream above the level of the land, from an elevated lake, or from reservoirs in which spring, rain, or other water has been stored up; and after it has been used for irrigation, it should be run into the stream lower down, or, if there is no stream, collected in shallows, and allowed to evaporate, or led down into porous strata. Wherever a good flowing river, or a high-lying lake is at hand, there is the least difficulty. Inundation canals is the simplest and rudest method; these are cut into the land from the river, and then made to run parallel with the stream. A series of small channels made to traverse the land, when well managed, is a very excellent method—just amounting to a number of artificial rivers with fertile banks. The lake system is common in Lombardy and Madras, and is very economical. The Arabs irrigate from large artificial wells or cisterns, sometimes boring into the mountains for a supply of water, which they lead out by canals. A good example of this last method is seen at Algiers, which the French supply in this way with a portion of its drinking water. In all cases of irrigation precaution must be taken against inundations, by providing well-secured floodgates, if necessary. There ought to be a plentiful supply of water under perfect control.

The character of the water employed for irrigation purposes must also receive attention. As already mentioned, all waters contain a certain amount of plant nourishment in solution and in suspension, but they may also convey substances detrimental to the plant. Care must be taken not to use such poisonous waters, for instance, as are drained from large forests, for they will paralyse the healthy action of the plant—we must not give the crops plant—sewage to drink!—or those, say, which are too heavily charged with calcareous matters, as they will deposit the lime and clog the pores of the plant—such waters, when carrying an excess of lime, should be freed of the larger portion before they are applied to the ground. The same applies, in a like general way, to iron or other such waters.

But here, as in all important operations, the exercise of a discriminating intelligence is required. The composition of the soil and the nature of the crop must be taken into account. Iron waters, for instance, are suitable for irrigating limey soils, and lime waters are useful for sandy soils, but when such waters are used they should be run on only at the end of autumn or in winter, and nothing but pure water used in the spring. It is always safe to irrigate with drinking water.

Other things being equal, those waters which yield the best fish are just those likely to yield the best plant, for the nourishment they contain is alike suitable for plant and animal. Many rivers are turbid with fertilising matter, and are, consequently, peculiarly applicable for irrigation purposes. The Ganges, for instance, carries down $\frac{1}{200}$th part of its volume of mud, or 2,509 million cubic feet per hour; the Nile conveys a still larger proportion of mud, $\frac{1}{120}$th of its bulk, or nearly 15 million cubic feet per hour. Meadows irrigated with water containing such valuable fertilizing properties are entirely independent of any further manure, indeed, very little soil even is needed. The famous water meadows of the Avon, in Wiltshire, for example, consist of beds of pebble and shingle, held together by the roots of the grass.

The affluents of the Humber bring down as much as 7 or even 8 per cent. by volume of deposit, which is employed for producing crops of wheat and beans. The same is effected on the banks of many other rivers—Seine, Clyde, &c.

Irrigation when applied to the meadow land produces a finer variety of grass, the coarser kinds die out and give place to the richer. If the water be allowed to stagnate, however, the coarser grasses again assert themselves, as is seen in marshy ground. This is a most important principle in irrigation—the water must never be allowed to stagnate, but be kept in constant circulation. For this a porous soil and especially a porous subsoil is needed, hence irrigation often requires to be preceded by drainage, in order to get the soil into a healthy open condition. The necessity for underground drainage as a preliminary is conspicuously the case with such ground as peat bogs and stiff clays. When the ground is very level, it is best to prepare it for irrigation by arranging it artificially into large furrows. Between each watering, the soil requires to be exposed dry to the air for some days at least. It appears pretty well agreed that water should be largely applied to the water meadows in winter, but very sparingly in spring, which is indeed the most critical season for the irrigators. During the frost there is no growth of grass, but if water be kept running over it, growth continues, and all chance of injury from frost effectually prevented. When the temperature rises again, however, the flow should be discontinued. The fields are then in a condition to grow rapidly whenever spring begins to appear, and they are luxuriant when the dry meadows are just recovering from their winter's torpitude. After the first crop, the water is run on again to prepare for a second, and in this way three or four crops are obtained.

The increase in crop effected by the latest Italian scheme has been estimated by the Commissioners as follows. They divide the soil into four qualities, according to the proportion of sand and clay it contains. When wheat, rye, maize, mulberry trees, grass, &c. are grown—

| | Per acre. |
|---|---|
| The most sandy ground in the dry condition yields about | £2 10s. |
| The same when irrigated, and with new crop rotation . . | £5 1s. |
| The most clayey soil in the dry condition yields . . . . | £3 10s. |
| The same under irrigation . . . . . . . . . . . . | £5 10s. |

The increase on the four varieties of land is—

| | Value of increase per acre. | | |
|---|---|---|---|
| | £ | s. | d. |
| For the most sandy . . . . . . . . | 2 | 11 | 9 |
| ,, 1st intermediate . . . . . . . . | 2 | 5 | 0 |
| ,, 2nd ,, . . . . . . | 2 | 2 | 0 |
| ,, the most clayey . . . . . . . . | 2 | 0 | 0 |
| Mean . . . . . . . . | £2 | 4 | 8 |

These are probably considerably understated, although they show the crop to be doubled on sandy soil, and increased by three-fourths on the most clayey. In India, the yield of rice obtained by irrigation is quadrupled, the wheat is increased by one-half.

To show what may be done in our own country by irrigation, one good instance may suffice. Two acres on a Berkshire farm, that previous to irrigation yielded a crop scarcely worth cutting, after irrigation could feed 73 sheep for five months. When compared with a field of the best Lincolnshire turnips, and with good unirrigated grass land, the relative value becomes more strikingly apparent—

| | |
|---|---|
| An acre of the turnips supports . . . . | 10 sheep. |
| ,, grass land supports . . . . | 14 ,, |
| ,, irrigated land supports . . | 36 ,, |

This Berkshire farmer was rewarded with 30 per cent. interest on the money expended on the enterprise. Our farmers would do well to reflect on this and *act*, especially as the returns show that between 1868 and 1871 there was a decrease in the number of sheep in the kingdom amounting to 12 per cent. of the whole. Irrigation will correct this, *and double the increase of the land.*

## FACTORY NEAR BASSE-TERRE.

A subscription was commenced on May 5th with the view of forming a company, (unlimited) for the establishment of a Sugar Factory at Bologne, near Basse-Terre.

The stock is fixed at 1,000,000 francs (£50,000). The shares are 500 francs (£25). The total subscription is payable in quarterly instalments. The first quarter will be due on the 15th June next; the three other quarters on 30th November, 1873, and 31st May, and 30th November, 1874.

Subscribers have the privilege of making anticipatory payments, provided that these payments are not less than one-quarter of the shares.

Subscriptions will be received with or without immediate payment; reserving in the latter case realization of the first quarter before the 15th of June. All instalments will produce interest at the rate of 6 per cent. per annum from the day of payment.

Subscriptions and payments are received—

1. By M. Payen, Notary, Basse-Terre, Rue des Normands, No. 7
2. At the house of the undersigned, Basse-Terre, Rue du Domaine, No. 5.
3. At the Bank of Guadaloupe, Pointe-à-Pitre, where the payments will be centralized.

Copies of the statutes of the society will be deposited at the before mentioned places, and at all Mayoralties of the colony.

Emle. Dentu.

*Basse-Terre, April 30th, 1873.*

## COLONIAL SUGAR MAKING.

The Government of St. Lucia have introduced an ordinance to establish a central factory system for the production of sugar. The Legislation has guaranteed the undertaking against loss. A contract is to be entered into between the factory company and the cultivators, by which the latter will receive 5lbs. of sugar for every 100lbs. of canes, the sugar to be paid for at the mean rate of the English markets.—*Greenock Sugar Trade Review.*

Serious Accident in a Greenock Sugar Refinery.—While three men were engaged on Monday working at a char cistern in the Dellingburn Sugar Refinery, Greenock, a spark from the wick of the lamp carried by one of them fell to the bottom of the cistern, and instantaneously ignited the inflammable compound with which they were working. The flames at once rushed up the sides of the cistern, burning the three men in a frightful manner. One of them, named Smith, is not expected to recover.

## REVIEW.

Observations on the Agricultural Chemistry of the Sugar Cane. By T. L. Phipson, Ph.D., F.C.S., &c. London: Ranken and Co., Strand. 1873.

It is with great pleasure that we see any work on agricultural chemistry, and the above contribution to it by Dr. Phipson is very welcome.

This branch of Chemistry, although still in its infancy, and being dragged hither and thither by opposing hands, has yet laid down certain laws (we are afraid we must call them so for want of a better word), and now, the foundations being laid, the various builders are steadily working at the different parts of the superstructure.

Dr. Phipson's name is well known to the readers of "The Sugar Cane," and they must indeed be pleased to see a work from the pen of a man who spends so much of his time in experimenting on the various branches of sugar manufacture.

In itself the book is very interesting and touches on many points of value to the manufacturer. At the beginning Dr. Phipson treats very shortly of the general commencement of agricultural chemistry. We think this part might have been expanded with benefit, negative results are often as useful as positive results, and we all find ourselves ready and generally able to profit by the failures of others. We shall try to give a general idea of the nature of the book, and would first quote from the very beginning a paragraph which from its general interest will be instructive.

Columella of Cadiz, in his book "De Re Rustica" speaking of the state of agriculture in his time makes the following statement:

"I see around me Schools for preachers, dancers, musicians, tumblers; cooks and barbers are also in vogue; houses of ill-fame and gambling establishments every where attract the imprudent youth; but as to the art which teaches how to fertilize the earth it has neither professors, pupils, justice, nor protection. * * * And if I complain of this neglect I am told the soil has become barren! * * *"

Although nearly 1800 years since these words were written, how true would they have been, if instead of 18 centuries having passed, no more than 18 years had gone away. Until but lately agricultural chemistry had neither "professors, pupils, justice, nor protection" in this country, and then as in those far distant years, the loud complaint was heard "behold, our *land* is left unto us desolate."

Liebig, who we think must be looked upon as the father of agricultural chemistry, came long ago to the opinion that the mineral portions of the plant are the food upon which it existed, and although this idea has been refuted by many able chemists, the theory in most cases, holds pretty true. When we burn a plant and examine the ash we find we have deprived it, to a very great extent, of some of the most important parts of its composition.—Nitrogen.—And when we return the "mineral" constituents of the plant to the ground on which it grew, we forget that this most important constituent has not been added. The results arrived at by many years' study of the subject, may be summed up in the few words in which Dr. Phipson does it in his little book "*The largest crops were obtained when the mineral and nitrogenous manures were employed together.*"

As we are in this number rather limited in space, we shall give in our next months' issue an extended review of this valuable book.

## Correspondence.

### CONCRETE *versus* MUSCOVADO.

323, Vauxhall Road, Liverpool,
9th July, 1873.

To the Editor of "The Sugar Cane."

Sir,

We suppose that information as to prices obtainable for sugar in the United Kingdom is always interesting to your West Indian friends, and as we observe that Fryer's "Concretor" is continually coming into use in sugar growing countries from whence we never saw concrete make a previous appearance, we beg to inform you that we bought in Liverpool, this week, forty tons of Fryer's concrete, from Montserrat, at 23s. 9d. duty paid (duty about 2s. 3d.) At the same time, and out of the same ship, and as we are told by the sellers, from the same estates, we bought ordinary muscovado sugar at prices varying from 18s. 3d. for dabs, to 22s. 9d.; the average price for 160 tons being about 22s. duty paid (duty 2s. 1d.)

Concrete, in this case, fetching fully 1s. 6d. per cwt. more than muscovado sugar.

We are,
Your obedient servants,
Crosfield, Barrow & Co.

## STATEMENT OF STOCKS, &c., of Sugars and Molasses, at the Ports of Greenock and London, from 1842 to 1872 inclusive, and other Statistics.—*From Greenock Sugar Trade Review.*

| | SUGARS. | | | | | | MOLASSES. | | CUSTOMS REVENUE. Greenock. | RATES OF DUTY ON SUGAR. |
|---|---|---|---|---|---|---|---|---|---|---|
| | Stocks at Dec. 31 | | Imports. | | Home Consump. | | Stocks. | Home Con. | | |
| | Greenock | London. | Greenock | London. | Greenock | London | Greenock | London. | Thousands of pounds to nearest thousand. | |
| | IN THOUSANDS OF TONS TO THE NEAREST THOUSAND. | | | | | | | | | |
| 1842 | 7 | Unascertained. | 17 | Unascertained. | 10 | Unascertained. | 5 | 13 | £308 | B. P. 25/3, Foreign 63/0. |
| 1843 | 7 | | 20 | | 13 | | 11 | 8 | 348 | B. P. 25/3, Foreign 63/0. |
| 1844 | 3 | | 17 | | 15 | | 6 | 16 | 367 | B. P. 25/3, Foreign 63/0. |
| 1845 | 2 | | 24 | | 22 | | 3 | 17 | 288 | B. P. 14/0 and 16/0, Foreign 23/4 and 28/0. |
| 1846 | 4 | | 26 | | 25 | | 1 | 17 | 324 | B. P. 14/0, Foreign 21/0. |
| 1847 | 11 | | 41 | | 33 | | 11 | 14 | 407 | B. P. 14/0, Foreign 19/6. |
| 1848 | 16 | | 39 | | 34 | | 7 | 17 | 437 | B. P. 13/0, Foreign 18/6 and 20/0. |
| 1849 | 11 | | 26 | | 30 | | 13 | 20 | 372 | B. P. 12/0, Foreign 17/0 and 18/6. |
| 1850 | 8 | | 34 | | 35 | | 12 | 24 | 383 | B. P. 11/0, Foreign 15/6 and 17/0. |
| 1851 | 17 | | 49 | | 38 | | 12 | 20 | 410 | B. P. 10/0, Foreign 14/0 and 15/6. |
| 1852 | 9 | 70 | 39 | 192 | 42 | 192 | 5 | 20 | 429 | B. P. 10/0, Foreign 13/0 and 14/6. |
| 1853 | 7 | 52 | 40 | 197 | 40 | 198 | 4 | 25 | 426 | B. P. 10/0, Foreign 12/0 and 13/0. |
| 1854 | 12 | 74 | 54 | 243 | 49 | 202 | 5 | 25 | 548 | B. P. and Foreign equalized 11/0 and 12/0. |
| 1855 | 9 | 40 | 42 | 202 | 40 | 218 | 4 | 22 | 570 | Ditto ditto 13/9 and 15/0. |
| 1856 | 3 | 42 | 34 | 224 | 38 | 196 | 3 | 21 | 608 | Ditto ditto 13/9 and 15/0. |
| 1857 | 4 | 57 | 44 | 221 | 38 | 191 | 6 | 10 | 448 | Ditto ditto 12/8 and 13/10. |
| 1858 | 5 | 54 | 61 | 229 | 57 | 219 | 5 | 15 | 655 | Ditto ditto 12/8 and 13/10. |
| 1859 | 5 | 58 | 71 | 233 | 70 | 215 | 1 | 10 | 809 | Ditto ditto 12/8 and 13/10. |
| 1860 | 4 | 53 | 74 | 229 | 75 | 222 | 2 | 5 | 802 | Ditto ditto 12/8 and 13/10. |
| 1861 | 7 | 73 | 92 | 251 | 89 | 216 | 4 | 18 | 908 | Ditto ditto 12/8 and 13/10. |
| 1862 | 18 | 65 | 120 | 209 | 107 | 208 | 2 | 15 | 1111 | Ditto ditto 12/8 and 13/10. |
| 1863 | 23 | 76 | 127 | 237 | 121 | 210 | 2 | 6 | 1234 | Ditto ditto 12/8 and 13/10. |
| 1864 | 24 | 110 | 129 | 228 | 126 | 180 | 3 | 3 | 1058 | Ditto ditto 8/2, 9/4, and 10/6. |
| 1865 | 30 | 85 | 134 | 207 | 137 | 214 | 2 | 4 | 1236 | Ditto ditto 8/2, 9/4, and 10/6. |
| 1866 | 14 | 89 | 148 | 206 | 162 | 190 | 2 | 3 | 1441 | Ditto ditto 8/2, 9/4, and 10/6. |
| 1867 | 14 | 67 | 179 | 186 | 178 | 203 | .. | 3 | 1500 | Ditto ditto 8/0, 9/7, and 10/6. |
| 1868 | 26 | 72 | 183 | 199 | 171 | 181 | .. | 5 | 1475 | Ditto ditto 8/0, 9/7, and 10/6. |
| 1869 | 14 | 76 | 145 | 194 | 156 | 182 | 2 | 2 | 1366 | Ditto ditto 8/0, 9/7, 10/6, & 11/3. |
| 1870 | 23 | 69 | 206 | 202 | 196 | 197 | 4 | 5 | 1107 | Ditto 4/0, 4/9, 5/3, and 5/8 } Payable on Landing Weights. |
| 1871 | 22 | 41 | 211 | 193 | 212 | 213 | 1 | 5 | 995 | Ditto 4/0, 4/9, 5/3, and 5/8 |
| 1872 | 50 | 67 | 233 | 212 | 209 | 178 | 1 | 4 | 998 | Ditto 4/0, 4/9, 5/3, and 5/8 |

The Stocks in Greenock are from the Official Statements, and exclusive of Cargoes arrived, with the exception of the return for 1872, which includes all arrivals in Port.

### STOCKS OF SUGAR IN THE CHIEF MARKETS OF THE WORLD ON THE 1ST JUNE, FOR THREE YEARS, IN THOUSANDS OF TONS, TO THE NEAREST THOUSAND.

| | 1873. | 1872. | 1871. |
|---|---|---|---|
| Great Britain | 147 | 75 | 124 |
| France | 99 | 55 | 73 |
| Holland | 64 | 42 | 39 |
| Germany (Zollverein) | 11 | 9 | 23 |
| Six other *entrepôts* | 9 | 3 | 5 |
| Total in Europe | 330 | 184 | 264 |

### CONSUMPTION OF SUGAR IN EUROPE AND THE UNITED STATES, FOR THREE YEARS ENDING 1ST JUNE, IN THOUSANDS OF TONS.

| | 1873. | 1872. | 1871. |
|---|---|---|---|
| Great Britain | 714 | 686 | 719 |
| France | 248 | 273 | 290 |
| Germany (Zollverein) | 254 | 207 | 214 |
| Holland | 28 | 25 | 26 |
| Six other *Entrepôts* | 102 | 104 | 97 |
| Total in Europe | 1,346 | 1,295 | 1,346 |

### ESTIMATED CROP OF BEET ROOT SUGAR ON THE CONTINENT OF EUROPE, FOR THE ENSUING SEASON, COMPARED WITH THAT OF THE THREE PREVIOUS SEASONS.

*(From Licht's Monthly Circular.)*

| | 1872-73. | 1871-72. | 1870-71. | 1869-70. |
|---|---|---|---|---|
| | Tons. | Tons. | Tons. | Tons. |
| France | 395,000 | 335,000 | 289,000 | 289,000 |
| Germany (Zollverein) | 260,000 | 189,000 | 263,000 | 217,000 |
| Austro-Hungary | 205,000 | 162,000 | 182,000 | 151,000 |
| Russia and Poland | 150,000 | 90,000 | 135,000 | 133,000 |
| Belgium | 80,000 | 72,000 | 56,000 | 44,000 |
| Holland and other Countries | 35,000 | 25,000 | 17,000 | 12,000 |
| Total | 1,125,000 | 873,000 | 942,000 | 846,000 |

## SUGAR STATISTICS—GREAT BRITAIN.

To 12th June, 1872 and 1873. In Thousands of Tons, to the Nearest Thousand.

| | STOCKS. | | | | | | IMPORTS. | | | | | | DELIVERIES. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. |
| British West India | 26 | 6 | 2 | 22 | 56 | 45 | 51 | 11 | 7 | 32 | 101 | 92 | 42 | 6 | 8 | 26 | 82 | 68 |
| British East India | 14 | 2 | .. | .. | 16 | 4 | 17 | 3 | .. | .. | 20 | 9 | 12 | 4 | .. | .. | 16 | 13 |
| Mauritius ...... | 3 | 1 | .. | .. | 4 | 4 | 10 | 13 | 11 | 11 | 35 | 34 | 11 | 2 | 11 | 12 | 36 | 34 |
| Cuba .......... | 4 | 4 | 1 | 15 | 21 | 18 | 3 | 7 | 7 | 22 | 39 | 42 | 4 | 4 | 7 | 19 | 34 | 34 |
| Porto Rico, &c. .. | 1 | 10 | .. | 1 | 12 | 8 | 2 | 17 | .. | 5 | 24 | 14 | 3 | 10 | .. | 3 | 16 | 10 |
| Manilla & Java .. | 28 | 9 | .. | 2 | 39 | 14 | 20 | 8 | 6 | 6 | 40 | 33 | 14 | 5 | 6 | 7 | 32 | 42 |
| Brazil .......... | 4 | 30 | 12 | 6 | 42 | 19 | 7 | 47 | 5 | 9 | 68 | 60 | 5 | 31 | 3 | 9 | 48 | 56 |
| Beetroot, &c. .... | 2 | .. | .. | 1 | 3 | 4 | 18 | 8 | 6 | 17 | 49 | 56 | 22 | 10 | 7 | 27 | 66 | 67 |
| Total, 1873 .. | 82 | 62 | 5 | 47 | 196 | 116 | 128 | 104 | 42 | 102 | 376 | 340 | 113 | 72 | 42 | 103 | 330 | 324 |
| Total, 1872 .. | 42 | 25 | 8 | 41 | 80 increase | | 94 | 76 | 45 | 125 | 36 increase | | 93 | 77 | 44 | 110 | 6 increase | |

# STATE AND PROSPECTS OF THE SUGAR MARKET.

During the past month the sugar market has undergone little change, and closes with a very steady appearance.

Good refining sugars have been in fair demand, and prices are becoming somewhat firmer. "The run is still upon good dry qualities which can be turned quickly through the refinery at a small cost for waste, labour, and charges. All brown and yellow sugars, on which the cost of refining now forms a heavy percentage, are resorted to only when the former cannot be readily obtained."—*Macgregor's Weekly Report.*

No. 12 Havana afloat is worth 26s. 6d. to 27s. 0d., against 29s. to 29s. 6d. last year. Fair to good refining Cuba Muscovadoes, 21s. 6d. to 22s. Middling to good brown Bahia, 17s. 6d. to 18s. 6d.

For the year the imports show an increase of about 28 tons; the deliveries an increase of about 7 tons; whilst the stocks up to 12th July show an increase of about 82 tons. Those, however, of which the largest stock has accumulated are the Brazil, British East India, and Manilla sugars. Although the current prices are low, yet the appearance presented by the market is a very steady one.

We think that the low prices, which a heavy stock occasions are not likely to recede further; on the contrary, the increasing consumption, which is the consequence of a duty now reduced almost to a mininum, will secure a satisfactory basis for a large and remunerative trade. The consumption, as all admit, is the most important element in the question, this being satisfactory, time only is required to bring about a healthy condition of the market. The weather has for the past month been favorable to the development of the beetroot, and a large crop is anticipated.

THE

SUGAR CANE.

No. 50. SEPTEMBER 1, 1873. Vol. V.

☞ The writers alone are responsible for their statements.

*For Table of Contents, see opposite the last page of each Number.*

"On the Use of Wet Megass as Fuel." By A. Fryer.—This article will be continued in our next number.

## ON THE CONVERSION OF STARCH INTO SUGAR IN THE HUMAN BODY.

(*Continued from page* 413).

I have already said (page 413) that the action of the saliva on boiled starchy matter is much more rapid than when the starchy matter is exposed to it in a raw condition. This is an experiment any one can try for themselves. In the case of invalids for instance, all may take note of the fact, that the bread given to them is generally "toast"—Why is this? The answer generally given is because "it is lighter and more easily digested," which in this instance may be really changed to the observation, "because the starch contained in the bread is in a condition in which it can be more easily converted into sugar." Any one who cares to place a piece of bread in the mouth—first "toast" then "plain"—will find the difference at once. The "toast" will become sweet to the taste almost immediately, whilst the "plain" will require a little time to allow the action of the saliva upon the starch to take place. Again all must remember that even in this case the slowness of the conversion is rapid, but this is accounted for by the fact that the bread "plain" has already been exposed for a certain time to the action of heat, the action being by this exposure sensibly quickened.

In *Public Health* for August, 1873, there are some observations on this subject relative to the digestibility of starch by infants, which is too important to be passed over with a mere notice, I therefore give it *in extenso*.

"As it is plain that all food to be nutritive must be capable of digestion, the very existence of young infants depending upon the proper understanding of their functional powers in this respect, we have been induced to complete a special series of experiments for the purpose of illustrating this most important question.

"It has been already stated in our last number that young infants are incapable of digesting starch, and we adduced excellent authorities for the assertion. But we believe that nothing carries conviction to the mind so impressively as the unvarnished record of actual experiment. To this end we have had in attendance, infants of various ages, from soon after birth up to 10 months old. The results of testing the transforming power of their secretions would occupy more space than can be here afforded, we have therefore selected one representative case, and compared the quantative action of infant saliva upon starch with that produced by the saliva of a healthy adult under precisely parallel conditions.

"It must be premised, that the action of saliva is partly mechanical, and, in its mixture of viscid liquid with the disintegrated particles of food, it entangles an extraordinary quantity of air in bubbles. Liebig assigns to this peculiar property a very great digestive and transforming value, but we must admit we have failed to discover any chemical action of the air upon starch in these experiments.

"The true specific function of the saliva is the conversion of the starch into glucose or sugar, and, unless the starch is so transformed, either by the saliva or the juices of the pancreas, it will pass through the bowels intact, or be acted on by other ferments so as to change into lactic acid and generate vast quantities of intestinal gases.

"It might be supposed that we could estimate accurately the transforming power by the proportional amount of ptyalin contained in various salivas, but this is hardly the case, for the quantities of ptyalin (albuminous substance insoluble in alcohol), found in unhealthy saliva giving an acid reaction, does not of necessity differ from that obtainable from the normal secretion. Yet the unhealthy acid saliva has but small power in transforming starch into sugar, although there is a very great tendency to change it directly into lactic acid.

"True digestive functions must therefore be estimated by the direct action of the saliva on the starch, and at a temperature equal to that of the body.

"From a healthy female child aged four months and seventeen days, various samples of saliva mixed with oral mucus were procured, and compared throughout the experiments with samples of the same weight obtained from an adult female of twenty-four years old.

"Experiment No. 1: Into four graduated test tubes, each containing 70 grs. of saliva, 10 grs. of Curcuma arrrowroot (dry) were dropped, the tubes being instantly immersed in a water bath kept accurately at 103° Faht. Test tube No. 1 contained adult saliva and starch, No. 2 adult saliva alone, No. 3 infant saliva and starch, No. 4 infant saliva only. At the end of an hour No. 1 showed a discoloration of the starch to the extent of one-eighth of its bulk, there being no change in No. 3. After four hours, rather more than a third of the starch in No. 1 had become a light drab, while no apparent alteration could be seen in No. 3. On analysis, lactic acid was predominant in all four tubes, but so copiously in No. 1 that the normal constituents of the saliva could not account for anything like the quantity. This was proved by an examination of the contents of No. 2. In No. 3 the lactic acid was only traceably in excess of No. 4, which contained the infant's saliva without starch.

"Under the power of a good objective, the starch granules of No. 1 proved to be so curiously eroded and acted on by the adult saliva that a *camera lucida* drawing was at once made. A similar drawing was also taken of the starch from No. 3 tube, for the purpose of demonstrating the difference of the action between adult and infant saliva, this latter sample manifesting no alteration of appearance under the microscope from that presented before treatment.

"Experiment No. 2: 10 grs. of pure rich starch were boiled for ten minutes in 100 grs. of water and divided equally between two test tubes, 50 grs. of each saliva were then added and the test tubes heated at 103° for ten minutes. Tested with five inches dilute solution of iodine, the adult saliva and starch showed a brown colour to the depth of one sixth of an inch; the same quantity producing a deep blackish purple in that of the child, and it descended in the tube for more than an inch. The tubes were shaken, upon which the colours instantly disappeared out of the adult saliva, but diffused itself all over the other, and when a very small quantity of chlorine-water was thrown in to set free a portion of the iodine, the characteristic blue colour was very strongly produced in the starch subjected to the infantile secretion, while in that of the adult no shade of colour could be seen.

"Experiment No. 3: 10 grs. of rice starch boiled to a jelly were mixed with 30 grs. of each saliva, to imitate fairly the proportion in which saliva is mixed with a purely farinaceous diet in the human system. In half-an-hour's digestion at 103°, nearly half of that mixed with the mature secretion was rendered soluble as glucose, and the rest was more or less changed, while two hours afterwards 8·7 grs. of starch were precipitated by alcohol from the saliva of the child.

"From these experiments it is evident that the saliva of an infant between four and five months old has no action whatever on insufficiently cooked arrowroot, but that healthy adult secretion has considerable transforming power. The process, however, is so slow and requires so much time that if sugar is formed it is carried further into lactic acid, some of which is simultaneously formed before any real estimate of the amount of saccharine change can be made. Insufficiently cooked, that is, unexpanded starch is thus demonstrated to be objectionable to persons of all ages, but not in the same degree.

"Secondly, the marvellously delicate colour test by iodine reveals that healthy adult saliva entirely transforms well boiled starch, and in the shortest space of time, but after ten minutes digestion in a superabundance of infant's saliva the starch remained as sensitive as ever to the test.

"Thirdly, the precipitation of 8·7 out of 10 grs. of well-boiled starch submitted to the infantile secretion, for more than two hours, conclusively proves that, at the best, infants of the age indicated can only transform 12 per cent. of starchy food. The other experiments all tend to point out that even this small amount is not turned into wholesome glucose of sugar, but into lactic acid, which, the most advanced opinions declare, cannot but prove injurious to children, and may be almost deadly to very young infants. These remarks apply alike to all kinds of arrowroot, sago, and tapioca, and, particularly, to the so-called corn-flours which have been unfortunately so much recommended for infants' use."

## ECONOMY OF FUEL.

*Translated from a Pamphlet by M. Paul Charpentier, Civil Engineer, Paris.*

## PART FIRST.

### STUDY OF THE PRINCIPAL SYSTEMS OF HEATING IN PRESENT USE.

### CHAPTER FIRST.

*General Considerations on the Subject.*

### SECTION I.

This question of heating in general is very important, and very extensive. The solution of the problem, economy of fuel, interests every one; it is, therefore, really a social problem.

I shall try in the course of this study to grasp the foundation of this immense question, and I shall attempt to solve the various difficulties which must necessarily be encountered.

Dr. Percy, in his important work on Metallurgy, says:—

"Each of the elements thus dissipated in the metallurgical furnace represents a loss of productive force very slowly accumulated in our coal-basins during the long period of centuries which have passed since their formation. The enormity of this will most undoubtedly excite one day the recriminations of our descendants, who will see themselves despoiled of a rich heritage, wasted by carelessness or ignorance."

For many reasons these riches are squandered by us, but above all by reason of our ignorance of the very principles which govern combustion, and unhappily these do not change.

I shall commence by studying the manner in which combustibles are used, their theoretical (heat) power, how much of this is used, how much lost. I shall then show the methods by which I propose to diminish this loss to a very great degree.

The end of the present work is, to resume, to show the usefulness, the necessity of changing all combustibles into gas, and using them in that condition under certain circumstances.

## SECTION II.

For my part I consider that there is always combustion when there is chemical combination. In the manufacturing sense this word is understood to mean the production of heat resulting from the combination of a combustible with oxygen.

In order that combustion should be perfect, it is necessary:

1st. That the combustible and the burning material should be *intimately mixed.*

2nd. The first result can only be obtained if the two bodies are *of the same physical nature.*

3rd. These two agents should be brought together at the temperature necessary to make their combination perfect.

4th. In order to realize the third condition the flame should be disposed in a long line.

5th. The proportions of the combustible and the burning material *should be exactly approached by the result of the combustion.*

We will at present only treat of oil, I shall then show the application to other combustibles, with some varieties.

I shall take as a type of an oil one in common use, and of a known composition.

It is composed by weight of

| | | |
|---|---|---|
| Pure carbon | 65 | |
| Ash | 5 | |
| Water (hygroscopic) | 5 | |
| Tar | 5 | |
| Illuminating gas | 20 | making 27 c.m. at 0° |
| | 100 | |

The average composition of the illuminating gas is as follows :—

| | By weight. | By volume. |
|---|---|---|
| H | 1·20 | 13,39985 |
| $C_2H_4$ | 70·80 | 99,07070 |
| $C_4H_4$ | 8·00 | 6,32375 |
| CO. | 13·00 | 10,39294 |
| $NH_3$ ($AzH_3$) | 2·50 | 3,24410 |
| HS | 1·00 | 0,64925 |
| $CO_2$ | 3·50 | 1,77036 |
| | 100·00 | 134,85095 |

The 20 kilogs. of gas already mentioned will therefore contain—

| | By weight. | By volume. |
|---|---|---|
| H | 0·24 | 2,67997 |
| $C_2H_4$ | 14·16 | 19,81414 |
| $C_4H_4$ | 1·60 | 1,26475 |
| CO. | 2·60 | 2,07858 |
| $NH_3$ ($AzH_3$) | 0·50 | 0,64882 |
| HS. | 0·20 | 0,12985 |
| $CO_2$ | 0·70 | 0,35407 |
| | 20·00 | 26,97018 |

## SECTION III.

These compositions being considered right, let us now see what would be the theoretical calorific power of this oil. I shall admit that there is much truth in putting the formulæ $C_4H_4$ as that of tar. I shall then have as combustible elements :—

| | Kilogs. |
|---|---|
| Carbon, pure | 65 |
| Tar, $C_4H_4$ | 5 |
| H | 0·24 |
| $C_4 H_4$ | 1·60 |
| $C_2 H_4$ | 14·16 |
| CO. | 2·60 |
| HS. | 0·20 |
| | 88·80 |

If we suppose that by some means we can burn these substances perfectly, and utilize the heat disengaged, we will have found what we want, the calorific power of 100 kilogs. of this oil. In making this calculation, and adopting the calorific powers determined by M.M. Favre and Silbermann, we find the number:

803779,6

being 8038 units of heat for about 2lbs. of this oil.

In supposing this calorific power completely used, and adopting the numbers found by M. Regnault for the total heats of vaporization, we find by calculation that about 2lbs. of this oil can produce of dry gas 12 kil. 618 at 1 atmosphere, and 12 kil. 041 at at 15 atmospheres 356.

We shall see presently what these figures become in practice, and how they cannot be attained by the ordinary methods of burning.

The usual method of applying the heat of combustion to steam boilers is by means of a naked fire over a grate.

In all, or nearly all, these fire-grates, the fuel, whatever it is, is burned in a natural draught, with the use of a chimney. In this is one source of loss of heat against which precautions have been taken but with very little success.

As a general rule, combustion carried on on a grate, with a natural draught *cannot be* successful from a chemical point of view. We have already seen that one of the principal conditions is that of perfect mixture of the combustible and the burning matter, which cannot be done between a solid—carbon, and a gas—the air of combustion.

As regards the manner of judging the vaporization power of the oil, exactitude and knowledge have not always been present at the experiments which have been made. Hence certain exaggerated figures have arisen, the impossibility of which the following goes to prove.

The manner in which the vaporizative power of a given oil is generally determined is subject to many causes of error, of which this is the principal.

Vapour, containing more or less water, the weight of water used not being equal to the weight of vapour really produced. It is now understood that this proportion of water held might reach to or exceed 0·4 of the total weight.

## ANALYSIS OF CRUDE SUGARS AND SYRUPS.

By H. Landolt.

*Translated by J. M. Merrick, B.Sc.*

[For the purpose of fixing the duties on various sugars an agreement upon certain principles and standards was made on the 8th of November, 1864, by the agents of France, Great Britain, Belgium, and the Netherlands, and to establish these standards and the relations of one grade of sugar to the others, &c., a large quantity—3,200 centner—of crude beet-sugar was bought and refined at the Rhenish Union Refinery in Cologne.

The analyses needed in the progress of the work were made by Prof. Landolt, with the co-operation of Prof. Wüllner, and Drs. Tollens, Bettendorf, and Kempf, the first-named of whom has given a full account of the analytical research in the 103rd volume of Erdmann's *Journal für praktische Chimie*, of which the following is a most comprehensive and valuable contribution to our knowledge of sugar-analysis.—J.M.M.]

### 1. *Analysis of Crude Sugar.*

Crude beet-sugar contains the following chief constituents :—

1. Cane Sugar.
2. Inverted sugar.
3. Salts.
4. Organic colouring matters.
5. Insoluble constituents.
6. Water.

A. Determination of the cane-sugar and inverted sugar by means of the polarization saccharimeter.

For determining the percentage of sugar three different polarizing apparatus were used, namely:—

I. A Soleil's saccharimeter, made by Duboscq, of Paris, with a double plate quartz compensator and tubes 200 mm. long. On the linear scale of this instrument zero was fixed as usual by the use of an optically inactive substance—water—and 100° by the observation of the deviation of the ray caused by a plate of rock crystals exactly 1 mm. thick.

This rotating power coincides with that which is exerted by an aqueous solution of 16·35 grms. of pure cane-sugar in a tube 200 mm. long. Experiments, to be detailed, showed that the 0° and 100° points on this instrument were accurately fixed.

A simple index was employed for reading the scale, and the tenths of a division could be read with certainty. A gas lamp served as a source of light

From a great number of observations which were made with this instrument, it was found that the mean error of reading, with nearly colourless solutions and fresh eyes was ordinarily no more than ± ·02° of the scale. On the contrary, if the observer's eyes were tired, this might amount to ± ·04°, and if the solution were strongly yellow to ± ·08°.

In the use of this saccharimeter, 16·35 grms. of the sugar to be analyzed were weighed and the solution made up to 100 c. c. The solution was cleared by the simultaneous addition of acetate of lead and a solution of alum. [Nothing is said about a subsequent filtration over charcoal.—J. M. M.] The deviation of the ray observed in the tube 200 mm. long then gave directly the percentage of sugar in the crude sugar examined. Direct polarization gives, as is well known, correct results only when the solution contains, besides cane-sugar, no other optically active substance, as, for example, inverted sugar. Since this can[not] be the case with crude sugars the determinations were controlled by Clerget's inversion process. 50 c. c. of the before-mentioned solution were heated in a flask to 65° or 70° for ten minutes, with the addition of 5 c. c. of fuming hydrochloric acid, and then cooled. The cane-sugar was thus converted into inverted sugar, and the rotating power of the fluid—which now was negative—was obtained by observations made with a tube of 220 mm. length, the additional length ($\frac{1}{10}$, 5 being $\frac{1}{10}$ of 50) being required on account of the increase of volume due to the hydrochloric acid.

This method depends upon the fact, that of the various optically active substances which may be present in the solution, the dextro-rotatory cane sugar alone is altered by the hydrochloric acid.

The per cent. of sugar is reckoned from the rotation observed before and after inversion in the following manner, viz.:—

According to Clerget's experiments, a solution of 16·35 grms. pure sugar in 100 c. c. of water—which in Soleil's saccharimeter by direct polarization gives a deviation of 100°—shows after inversion, when the observation is made at 0°, a rotation of 44° to the left, or in other words a lessening of rotation of 144° has taken place.

The rotation of a solution of inverted sugar to the left is in a high degree dependent upon the temperature, and, indeed, this rotation with the above fluid diminishes by one-half a degree of Soleil's scale for each degree centigrade, the temperature of the sugar solution is raised, and at 0° C. is expressed by—

$$T^\circ = 144 - \tfrac{1}{2}\,T.$$

If $S$ = the sum of the saccharimeter readings before and after inversion, or the diminution of rotatory power of the original solution through inversion, $T$ = the temperature of the inverted solution at the time of observation, $R$ = the percentage of cane-sugar sought, then

$$144 - \tfrac{1}{2}\,T : 100 :: S : R \text{ or}$$
$$288 - T : 200 :: S : R,$$

whence

$$R = \frac{200 \quad S}{288 - T}$$

With the help of this formula was reckoned Clerget's well known table for the determination of cane-sugar by the inversion process.

The following experiments were made to test the method :—

1. A solution of 13·024 grms. pure loaf sugar in 100 c. c. of water gave in Soleil's apparatus—

$$\text{before inversion} + 79{\cdot}6^\circ = \left\{ \begin{array}{l} 13{\cdot}0146 \text{ grms.} \\ \text{or } 99{\cdot}90 \text{ per cent.} \end{array} \right.$$

after inversion — 26·9 at 20° C.

$$S = 106{\cdot}5$$

$$\frac{200 \quad 106{\cdot}5}{288 - \quad 20} = 79{\cdot}5^\circ$$

Corresponding to 12·9983 grms. or 99·80 per cent.

Difference = ·0163 " ·1 "

2. A mixture of cane-sugar and inverted sugar was prepared in the following way, viz.: from a solution, which contained 16·35 grms. dry refined sugar in 100 c. c., 10 c. c. were taken by means of a pipette and inverted with hydrochloric acid, whereby the 1·635 grm. cane-sugar contained in the 10 c. c. was converted into 1·721 grm. inverted sugar. To this latter solution, after its neutralization with carbonate of soda, was added 16·35 grms. pure sugar, and the whole made up to 100 c. c.

This fluid without the inverted sugar must have shown a rotation of 100°, but gave in this case—

By direct polarization + 97·10
After inversion . . — 37·50

$$S = 134{\cdot}60$$

corresponding to 99·70 per cent cane sugar. In this case, too, inversion had allowed the contents in cane-sugar to be estimated with telerable accuracy.

The inverted sugar present in the solution can be reckoned from the figures obtained in the above experiment in the following manner, viz.:—

Since, according to the researches of Clerget, we obtain by inversion from a solution containing 16·35 grm. cane sugar in 100 c. c. a fluid which at $T^\circ$ (zero) polarizes $44 - \frac{1}{2} T$ to the left, this rotation corresponds to a content of 17·21 grms. inverted sugar in 100 c. c.

Let $A$ = the amount given by direct polarization $R$ = the contents in cane-sugar found by inversion, and $I$ = the amount in grammes of inverted sugar sought, then

$$44 - \tfrac{1}{2}\,T : 17{\cdot}21 :: R - A : I$$
$$\text{or } 88 - T : 34{\cdot}42 :: R - A : I$$

and

$$I = \frac{34{\cdot}42}{88 - T}(R - A) \text{ grammes.}$$

$T$ signifies here the temperature of the solution during the direct polarization.

Since the change by heat can be of little influence on account of the smallness of the amount of inverted sugar, a constant value may be given to $T$, say 18°, and thence we have

$$I = {\cdot}492\,(R - A) \text{ grammes.}$$

In the above experiment $I$ was found to be 1·28 grm., instead of the true amount present, viz., 1·72 grm.

The estimation of the inverted sugar must always be somewhat uncertain, since here the errors of observation have great influence.

On heating a sugar solution with hydrochloric acid, the fluid takes on a somewhat strong brown tint which renders the polarization observation difficult.

In this case the volume of the solution may be doubled.

In general, the mean error of reading does not amount to more than ± ·2 of the scale, but it may exceed this. For example, sample No. 2—moist sugar—gave after inversion, at 20° C. 30° ± ·5. Direct polarization had given 89·6.

With regard to the possible error due to the apparatus, the inversion would have given the following percentages:—

| | | | |
|---|---|---|---|
| Rotation to right .. | 89·6 | 89·6 | 89·6 |
| ,, left .. | 29·5 | 30· | 30·5 |
| | 119·1 | 119·6 | 120·1 at 21° |

Corresponding to percentage of cane-sugar:—

| | | | |
|---|---|---|---|
| | 89·21 | 89·59 | 89·96 |
| Mean | 89·59 | ± ·38 per cent. | |

This shows that inversion may give the contents of the sample in cane-sugar with a variation from the truth of ± ·4 per cent.

When, therefore, the results of the direct and indirect polarization of a sample of crude sugar show differences up to the limit quoted, we are not justified in ascribing this behaviour to some other optically active substance, but the error can be accounted for as one of experiment. Above we have taken the most unfavorable case. On the average the experiments show ± ·2 as the highest error.

### *Ventzke-Soleil's Saccharimeter.*

This instrument was made by F. Schmidt, of Berlin, with a Soleil's double plate and quartz compensator, tubes of 200 mm. and 100 mm. length, and scale with vernier divided into tenths.

The point 100 on this scale was fixed by observations made in a tube of 200 mm. upon a solution of pure sugar of sp. gr. 1·1 at 17·5° C.

If a solution of the sugar to be analyzed is prepared of a sp. gr. of exactly 1·1 at 17·5° C., the rotation observed gives the amount of dry sugar in 100 parts of the crude.

Instead of adopting this method (which is used to avoid the employment of a balance), since a solution of sp. gr. 1·1 contains exactly 26·048 grms. sugar in 100 c. c., we may proceed by dissolving 26·048 grms. of the sugar to be analyzed in water to 100 c. c., and observing its polarizing power in the 200 mm. tube. This process is more exact than the first, in which the salts present in the crude sugar render the determination of the sp. gr. inaccurate.

The mean error given by the instrument employed was ± ·2 of the scale with clear solutions, and as high as ± ·8 with such coloured solutions as were daily observed.

### *Wild's Polaristrobometer.*

This was the larger form made by J. G. Hoffman, of Paris. This instrument had a graduated circle of ·1 metre diameter, with a vernier reading to ·02.

In the observations made a Bunsen gas lamp, in whose flame carbonate of soda was volatilized by means of a platinum wire, served as a source of light, and consequently the Savart-Wild double quartz was not employed, but the simple one belonging to the instrument, viz., a quartz crystal of 30 mm. length cut at an angle of 45° degrees to its optical axis.

The instrument was set for the disappearance of the interfering rays sometimes in all four quadrants, but generally to two opposite each other and corresponding to the crossed sections of the two Nicol's prisms.

The observations at these points are sharper than at the two others.

The polarizer was provided with tubes 50, 100, 200, and 300 mm. long, of which the 200 mm. tube was generally used.

The solutions were usually so concentrated that 20 grms. of the sugar to be examined was contained in 100 c. c. of the solution, or the solutions used were those proposed for the Soleil or Ventzke instrument.

The concentration of the solution $C$, that is the quantity of sugar which is contained in one litre, is reckoned from its gyrations of the rotation of the plane of polarization in Wild's othoretus, using the homogeneous light of the soda flame, according to the formula

$$C = 1505{\cdot}6 \frac{a}{L}$$

where $a$ is the angle of rotation of the ray, and $L$ is the length of the tube in millimetres.

The constant 1505·6 has been obtained by Wild through a research carried out with the greatest care with the help of the polaristrobometer. The accuracy of this constant is well confirmed by the fact obtained by experiments with Soleil's saccharimeter, viz., that 16·35 grm. sugar dissolved in 100 c. c. of water give a fluid which in a tube of 200 mm. long shows the same rotatory power as a plate of quartz 1 mm. thick.

Since in accordance with the coincident measurements of Broch* and Stefan† such a plate rotates a ray of light of the refrangibility of the line $D$, above an angle of 21·67°, we reckon from the above data the constant of Wild's formula with reference to the unit chosen by him, thus :—

---

* Dove *a.* Moser Report, *d.* Physic 7, 113.

† Pogg. Ann. 122, 634.

$$\frac{10_5\ 2 \quad \cdot 1635}{21 \cdot 67} = 1509$$

a number almost exactly that found by Wild.

For rapid reckoning of the value of $C$, tables are given by Wild. When a tube 200 mm. long is used $C = 7 \cdot 528\ a$.

It is a very easy process to turn the angle of rotation into degrees of the Soleil scale, and then to apply Clerget's tables when a sugar solution which has been inverted with hydrochloric acid is to be investigated by Wild's apparatus.

Determine first by the formula $C = 1505 \cdot 6 \frac{a}{L}$ the angle of rotation which a solution of 16·35 grm. sugar in 100 c. c. of water must give a tube 200° mm. long. $a$ will be found = 21·7189.

This same solution affects in Soleil's apparatus a rotation of 100°. Then

$$1° \text{ Wild} = \frac{100°}{21 \cdot 789} = 4 \cdot 6043° \text{ Soleil—}$$

or reversed 1° Soleil = ·217189° Wild.

To change Wild's degrees into Ventzke's, we have

$$1° \text{ Wild} = 2 \cdot 89005° \text{ Ventzke.}$$
$$1° \text{ Ventzke} = \cdot 346015° \text{ Wild.}$$

The mean error of reading in the instrument employed was ± .03, which not seldom went down to ± ·02, but with wearied eyes rose to ·1.

Below is given by way of example, a series of observations made with crude sugar No. 22. The solution contained 26·05 grm. in 100 c. c. of water, and was tested in tubes of 200 mm. The quadrants 1 and 111 were those which gave the sharpest readings. E. T. signifies empty tube, and F. T. filled tube.

In reckoning the amount of sugar, the rotation found must be increased $\frac{1}{10}$, since the fluid was decolorized with $\frac{1}{10}$ its volume of acetate of lead.

| Quadrant. | | Mean of readings. | Rotation of ray. | Sugar in 100 c. c. in grammes. | Sugar in per cent. |
|---|---|---|---|---|---|
| I. .... | E.T.<br>F.T. | 90.69°±·01<br>61·51°±·03 | 29·18° | 24·1634 | 92·76 |
| II. .... | E.T.<br>F.T. | 180·51°±·03<br>157·49°±·05 | 29·02° | 24·0309 | 92·25 |
| III. .. | E.T.<br>F.T. | 270·56°±·04<br>241·42°±·02 | 29·14° | 24·1303 | 92·63 |
| IV..... | E.T.<br>F.T. | 360·79°±·11<br>331·52°±·04 | 29·27° | 24·2379 | 93·04 |
| | | Mean = | 29·15° | 24·1385 | 92 66 |

*(To be continued.)*

# THE SACCHARIMETER: ITS FORMATION AND USE.

## By H. A. Smith, F.C.S.

*(Continued from page 285.)*

We have previously shown the method employed by Biot for determining the rotary power of various liquids.* He always employed, whether working with white or red light, a glass coloured red by oxide of copper, which he placed between the eye and the analyzer.† Biot's method of using this instrument was as follows:—The whole apparatus was placed in the interior of a cabinet, the sides of which were blackened. This cabinet had three openings. The shutter, every opening of which was carefully closed with black silk; the door, and a small window which could be opened or shut as required. Every care was taken that these three openings should be very carefully closed, so that no ray of light should be allowed to pierce into the box.

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* We have shown above (page 285,) the method of working the instrument designed by Biot, for determining the rotary power of different liquids. The description was one given by M. Verdet, of Paris—an excellent one in every respect but one, to which in one place an objection can be made. He there says, (*loc. cit.*), "the analyzer is then turned so as to produce the extinction of one of the two images, if homogeneous light is used, *or a decided tint, if white light is employed.*" The italics are our own. Here, I think a slight mistake is made, no tint can be obtained unless some highly refractive medium be between the analyzer and the polarizer, such as terebenthine or sugar, so that in Biot's case I must consider that "a slight shade" is meant, as this can be obtained by simply turning the polarizer. This part is, however, perfectly unnecessary.

This instrument of Biot's was modified somewhat by M. Soleil so as to serve the more particular purpose of titrating sugar solutions.* And to his instrument he gave the name which it now bears, the *Saccharimeter*. The theory of this instrument is based upon the fact that a piece of quartz of a certain thickness corresponds to a given length of an active liquid. So that the first point to be determined is,—to find the thickness of quartz which corresponds to a length of any active liquid, which length will be considered as *unity*. The method is a very exact one and is much easier of application than that of Biot.

The polarizer in a Soleil's saccharimeter is a Nicol's prism, rendered achromatic, the light passing through this falls upon a plate of quartz, if now the system composed of these two pieces be turned round the axis of the instrument, there is a tint produced, which changes the colour of the sensitive plate; but if the colour chosen be the complimentary one to the colour of the syrup,

---

† Biot found that the molecular rotary power of red light might be represented when the solution contained $e$ for 100 of water by the formula

$$[\rho] = a + b\,e,$$

$a$ and $b$ being two constants. This result has been verified and further extended to the different rays by M. Arudtsen, who gives the following values of the constants $a$ and $b$ for the different rays of the spectrum.

Ray $C$ ................ $[\rho] = +2^\circ{,}75 + 9^\circ{,}45e$,
,, $D$ ................ $[\rho] = +1^\circ{,}95 + 13^\circ{,}03e$,
,, $E$ ................ $[\rho] = 0^\circ{,}15 + 17^\circ{,}51e$,
,, $b$ ................ $[\rho] = 0^\circ{,}83 + 19^\circ{,}15e$,
,, $F$ ................ $[\rho] = -3^\circ{,}60 + 23^\circ{,}98e$,
,, $e$ ................ $[\rho] = -9^\circ.61 + 31^\circ{,}44e$,

* *Comptes Rendus*, xxi., 426; xxiv., 973.

the same end is attained as if the plate were colourless.

Again, most syrups contain besides crystallizable sugar, other active substances. It is, however, only the sugar that is in general wanted. In order to obtain this the syrup is treated with $\frac{1}{100}$ of its weight of fuming hydrochloric acid, and just brought to the boiling point, the sugar is thus changed into glucose, which turns the plane of polarization to the left. It is, in fact, as if the crystallizable sugar had been removed and its place supplied by an equivalent of glucose. The amount or weight is now easily calculated where the amount of rotation before and after this immersion takes place. Suppose, for example, K and K′ to be the molecular value of cane sugar and glucose respectively, $\pm$R the total rotation produced by foreign *active* substances mixed, then we have before and after immersion—

$$A = K\,l\,\delta\,\epsilon \pm R., \quad A' = K'\,l\,\delta\,\epsilon \pm R.$$

$$\text{then } A - A' = (K + K')\,l\,\delta\,\epsilon,$$

$$\text{therefore } \epsilon = \frac{A - A'}{l\,\delta\,(K + K')}.$$

I must now, however, describe the apparatus more minutely, having above merely given the rough outline of the manner of using the instrument.

(*To be continued.*)

## ON THE MANUFACTURE OF SUGAR FROM THE SUGAR CANE, AND THE MACHINERY EMPLOYED THEREIN.

### Part XV.

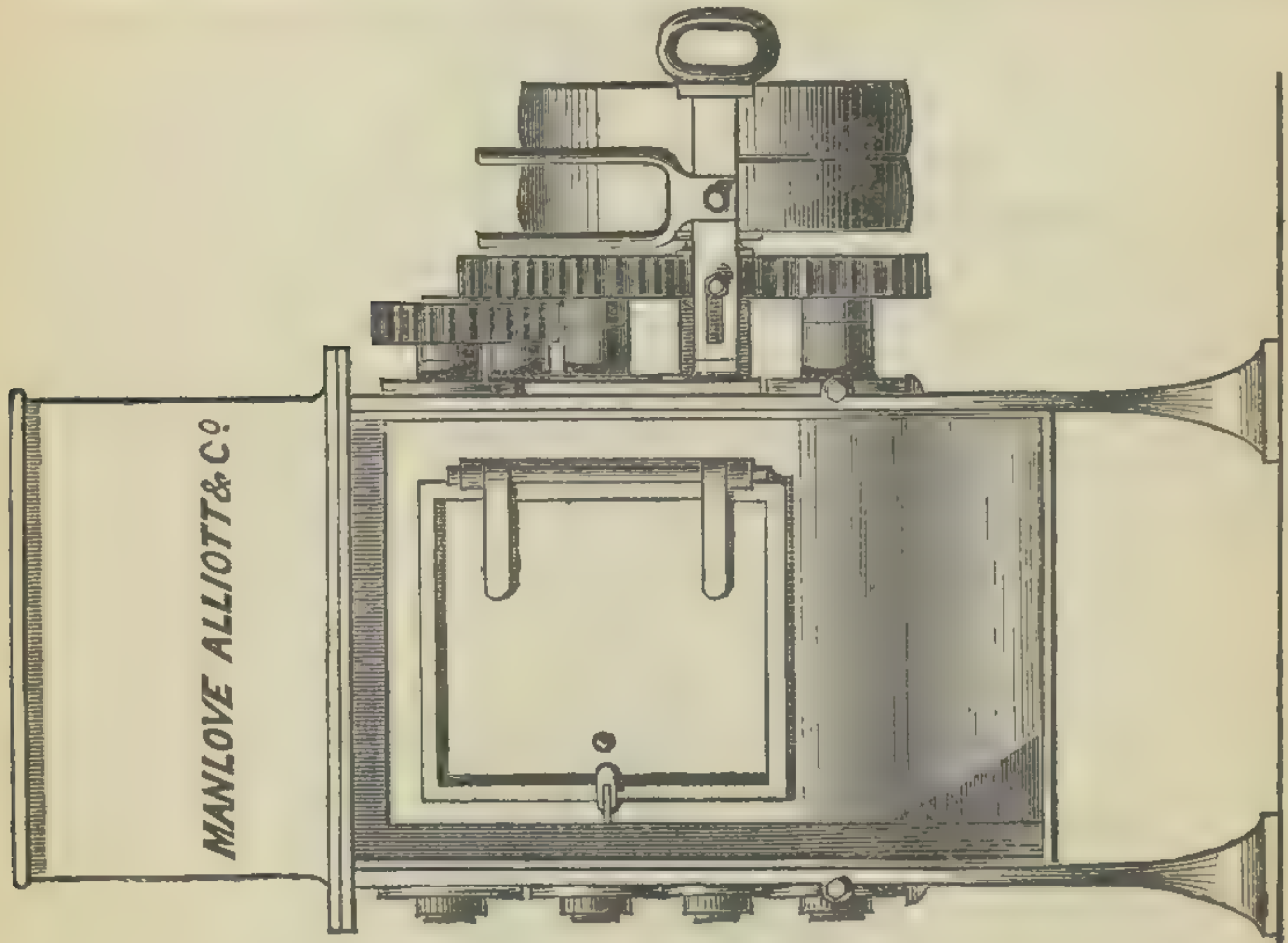
As mentioned in a former paper, the sugar, though some times brought hot from the vacuum pan to the centrifugals, is more usually allowed to remain for a time in the coolers before being cured, the crystals having thus more time given them to grow and become hard.

Where the concentration is effected in the Jamaica train the mass of sugar in the coolers is usually of such a consistency that it may readily be dug out and passed at once to the centrifugals; but where the syrup is highly concentrated, as it usually is in the vacuum pan, the mass in the coolers sets quite hard, and must be broken up before it can be cured. This breaking up of the mass has a double effect—it enables the molasses to drain away from the crystals much more readily, and it renders it much easier to distribute the mass of sugar evenly in the centrifugal, a matter which is of considerable importance to the easy and efficient working of that apparatus.

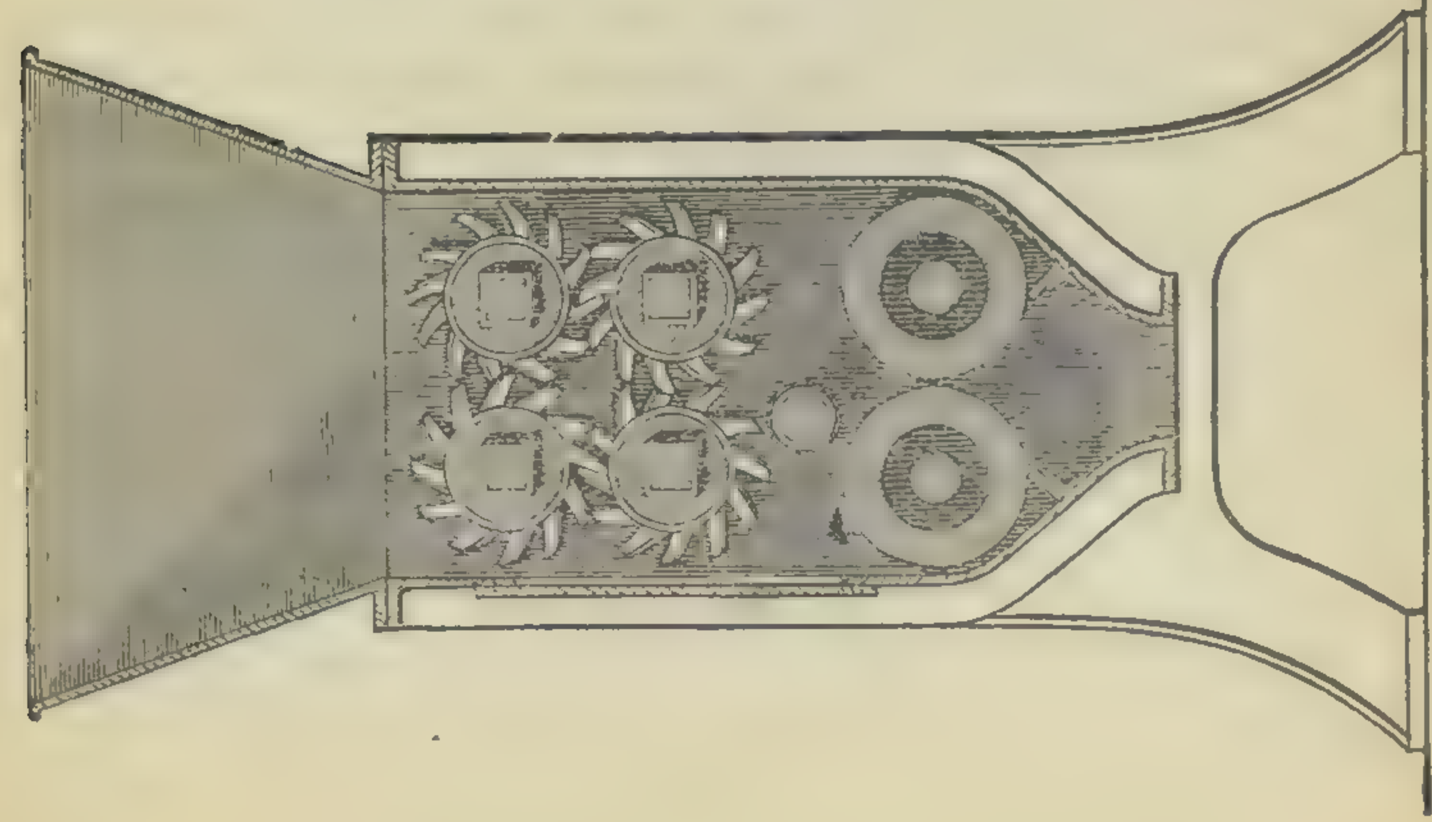
Several different machines are in use for the purpose of effecting this breaking up of the crystalline mass, and preparing it for the centrifugal. In the one which we illustrate, the mass is first placed in a hopper, at the bottom of which revolve rollers armed with projections, or "clawkers;" as these rollers turn towards one another the "clawkers" lay hold of the sugar, draw it in between them and very effectually break it up; after passing through a second pair of similar rollers, which again reduce the size of the lumps which still hold together, it passes through a pair of plain rollers which crush any small lumps which may have passed through the "clawkers" unbroken, and reduce the whole to a homogeneous mass.

Another arrangement of sugar crusher which also does its work very effectually, consists of a number of knives set in a spiral on a revolving shaft; these, as they revolve, pass between fixed knives, and thus effectually break up the mass of sugar submitted to their action. The knives, both revolving and fixed are much thicker at one end of the machine than at the other. The mass is first coarsely crushed by the thicker knives, and then by their spiral arrangement is forced gradually forward to the thiner ones, which of course reduce it into a more and more sub-divided state. The action of the whole is in fact exactly like that of Nye's sausage-making machine, though of course on a much larger scale.

Another method of curing is that known as "claying." When it is intened to treat the sugar in this way it must first be run into conical moulds, which should stand vertically, with the small end downwards, and which are so arranged that the drainings from them can readilly be collected and retained. The hole in the bottom of each of these moulds is at first stopped, and the sugar is stirred up once or twice after being put into them, in order to disperse the crystals, which collect on the sides and at the surface, equally throughout the mass. When the temperature of the whole has fallen to about 130° Fahrenheit, it should not be again



END ELEVATION



TRANSVERSE SECTION

disturbed. After the sugar has been in the mould for about a day, the hole in the bottom of the mould is opened, and to the surface is applied a "magma," consisting of clay and water beaten up into the consistence of thick cream. The clay gradually parts with the water which has been mixed with it, and this sinking down through the crystallized mass, gradually displaces the darker coloured syrup which before occupied the spaces between the crystals. This action takes place the more readily since a portion of the water unites with the syrup to render it more fluid. As the clay gradually becomes dry, it may be replaced by a fresh supply of "magma" until the water gradually percolating through the mass has driven before it the whole of the dark-coloured molasses. The longer this process is continued the whiter will be the sugar, but the greater also will be the loss in weight arising from a portion of the crystals being dissolved by the water. This and other inconveniences of the practice of claying have led to the very general substitution for it of the process of "liquoring." For this process the moulds are prepared precisely as for claying. When the sugar within them has attained a proper consistency, the crust which always forms on the top must be removed to the depth of one or two inches, and the surface must be rendered smooth and level. The sugar thus removed may be crushed up, mixed with water until it attains the consistency of mortar, and replaced in the mould. In the course of a few hours the excess of moisture will have disappeared, and the mould will be ready for liquoring. This operation consists in applying a saturated solution of sugar to the top of the mould. This, like the water from the clay magma, gradually percolates through the mass and displaces the dark syrup, while, being already saturated with sugar, it cannot dissolve any of the crystals which have already been formed; but for this very reason it cannot assist the drainage by rendering the darker syrup more liquid, but can only drive this latter before it.

The sugar used for preparing the "liquor," or "finings" as it is usually termed in the refinery, should be of the best quality easily attainable, since upon its whiteness depends the whitness of the sugar turned out from the moulds. It is by means of this process that all fine loaf sugar is rendered clean and white; but to obtain this result the liquor or "finings" need to be prepared from the very finest and whitest sugar, and the "massecuite" in the moulds must also be very pure and free from colour.

A year or two back an arrangement was patented by Mr. Kodl, of Ronov, for enabling the operation of liquoring, which, as our readers will have gathered, is a long and tedious one, to be greatly expedited. For this purpose he fitted a close top on to each mould, and then admitted liquor from a cistern situated some thirty feet or so above the moulds. There being thus a pressure of some fifteen or sixteen pounds on the inch driving the liquor through the moulds, the whole operation, which usually occupies several days, was accomplished in some six or seven hours. We believe that this system has yielded valuable results in the refinery, but probably the extra complication attendant on it, would more than counterbalance its advantages for colonial use.

Loaves which have been subjected to the ordinary claying process are usually very imperfectly clarified, and are rarely of the same colour throughout. They are therefore generally broken into three pieces, the quality of the top being the best, that of the middle next, and that of the small end of the loaf the worst. Each quality is kept to itself, and the whole is crushed down and packed in bags or hogsheads. When the liquoring process has been adopted, and sufficient care used to produce a white loaf of even colour throughout, it is often sufficient to trim only the top and the nose of the loaf.

In any case it is desirable to dry the loaves thoroughly in a stove heated to a moderate temperature, and where they are intended to pass into direct consumption this drying is essential.

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We have this month been favoured with a sample of very beautiful sugar, manufactured by Mr. Bennett, of Gairloch Estate, Brisbane. Analysis shows its composition to be—

| Crystallizable Sugar. | Incrystallizable Sugar. | Waste. |
|---|---|---|
| 96·3 | 1·7 | 2·0 |

We are pleased to see so pretty a sample from a quarter of the world where the sugar industry is yet so young.

# ACTION OF CRYSTALLIZABLE SUGAR ON THE POTASSIO-CUPRIC SOLUTION OF BARRESWIL.

By M. E. Feltz.*

*Translated by H. C. Humphrey.*

The estimation of glucose is founded on the reduction of the copper solution when heated to boiling in presence of this sugar. This reaction is very delicate; several cubic centimetres of a solution, containing about one-half a gramme of glucose to the decilitre, being sufficient to decolorize completely 10 c. c. of the standard solution. If we replace the solution of glucose by a similar use of cane-sugar, the solution of copper remains clear, and there is evidently no precipitation of suboxide of copper. From this fact it has been concluded that the crystallizable sugar exerts no action on the copper solution.

In endeavouring to estimate traces of glucose in solutions of crystallizable sugar, I have been led to establish the fact that cane-sugar can also reduce the copper solution. The following are the experiments which go to prove this fact:—

I. To 10 c. c. of copper solution, prepared according to the formula of Violette, was added 20 c. c. of a solution containing six grammes of refined sugar. The mixture was kept in a state of ebullition in a little flask. At the end of twenty-five minutes all the copper solution was precipitated, and the blue colour gave place to one of intense yellow.

II. The copper solution boiled, without addition of sugar, gave no precipitate.

III. The sugar solution, heated to boiling, with an excess of lime, was not discolored, which would have been the case had it contained inverted sugar in any notable quantity. The solution was deprived of the lime with which it had been boiled by means of carbonic acid, and was found to reduce the copper solution exactly as in Experiment I.

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* Communication to the Academy of Science.

The reduction of the copper solution could be attributed to the impurity of substances entering into its composition. I have purified, by successive crystallizations, both the sulphate of copper, and the double tartrate of potassium and sodium. Soda lime was replaced by pure soda. The standard solution thus obtained was not decomposed by boiling, but acted in presence of crystallizable sugar similarly to that used in Experiment I.

Many formulæ have been proposed for the preparation of the copper solution. That of Fresenius does not differ from that of Violette, except in the quantity of pure soda. M. Monier replaces Rochelle salts by cream of tartar. Other chemists give the preference to the neutral tartrate of soda. The solutions prepared with cream of tartar are generally abandoned, as the reduction with them is not delicate. But, in reality, the essential difference existing between the solutions prepared by the different formulæ consists in the different quantities of free alkalies. The solutions which are most alkaline give the most delicate reaction in presence of glucose, and are not as liable to alteration. Mr. Batterson, indeed, has lately proved that by the addition of a certain amount of soda, the good qualities of a solution which had been altered by too long concentration were restored.

The solutions (*a*) and (*b*) were prepared: (*a*) according to the formula of M. Violette, and (*b*) by that with neutral tartrate of soda, with a great excess of alkali. 10 c. c. of solution (*a*) contain 0·632 grm. of free soda. 10 c. c. of solution (*b*) contain 1·34 grms. of free soda. Heated to ebullition, with 20 c. c. of sugar solution containing 6 grms. of sugar, the 10 c. c. of solution (*a*) were decolorized after 25 minutes. Under the same conditions, 10 c. c. of solution (*b*) were decolorized in 10 minutes. In adding 0·600 grm. to the 10 c. c. of solution (*a*) the decolorization was completed at the end of 15 minutes. Thus the reducing action of cane-sugar upon the copper solution is greater the larger the amount of soda. The following four experiments were made with solution (*b*):—

I. 10 c. c. of solution (*b*) was decolorized by addition of 6 grms. of refined sugar in 10 minutes.

II. 10 c. c. of the same solution with 3 grms. of refined sugar was decolorized in 10 minutes.

III. 10 c. c. of solution (*b*) with 1·5 grm. of refined sugar was decolorized in 14 minutes.

IV. 10 c. c. of solution (*b*) with 0·6 grm. of refined sugar was decolorized in 30 minutes.

The refined sugar used in the preceding experiments was from the Russian Refinery of Comte De Bobrinsky. The experiments were repeated with Say sugar of the first quality, and afterwards white sugar, and in the form of beautiful crystals, from the refinery at Cologne. The results were similar. It thus appears, without doubt, that crystallizable sugar reduces the copper solution under influence of an excess of alkali. The estimations so frequently made of glucose in a mixture of the two sugars have only a relative exactness, and become entirely inaccurate as soon as it is necessary to estimate traces of glucose in the presence of large quantities of crystallizable sugar. Dr. Scheibler has already, in 1869, showed the relative inaccuracy of the estimation of glucose in a mixture of the two, by proposing, as a probable hypothesis, the reduction of the copper solution by crystallizable sugar.

## ON THE EFFECTS OF CUTTING DOWN THE FORESTS IN JAMAICA.

The following is an extract from the *County Union*, from the pen of Mr. Robert Russell, L.L.B.

"The very lucid and interesting Financial Statements of the Collector General, published in the *Gazette* of the 12th ultimo, among the various subjects therein treated, furnish the appalling fact, occurring in this Island, of 'short crops' arising from 'bad seasons and severe droughts,' in the several parishes of Saint Thomas, Saint Mary, Saint Ann, Manchester, Trelawny, Saint Elizabeth, and the hitherto 'weeping parish' of Portland; five of these are on the North side of the Island, and two on the South side, all stretching from the sea-board to some distance in the interior. Of the remaining six parishes two, viz., Saint Andrew and Westmoreland, appear to have been stationary in their products, as these have neither increased nor decreased. The other remaining four which evidence an increase, not wholly attributable to 'good seasons,' but to extraneous circumstances superadded, are Saint Catherine, embracing the two wholly inland districts of Saint John and Saint Thomas in the Vale, and the partially inland one of Saint Dorothy; the increase here is assigned to 'an influx of labourers,' and 'Cuban settlers' who, no doubt, pursue an improved system of cultivation which has augmented the former returns.

"Clarendon, a wholly inland district, including Vere (a seaboard not extending at its broadest part beyond twelve miles from the sea) shows an increase, but here also it is said to arise from an 'influx of labourers.' The last two parishes, Saint James and Hanover, owe *their* increase of crops to 'favourable seasons in some parts' of the former, and to 'fair seasons *probably*' in the latter. Looking at a map of Jamaica it will be seen that all the parishes are mountainous, and with the exception of Saint Catherine, Saint Dorothy, and Vere, which are slightly so, extend more or less to the elevated centre of the Island, yet these districts, with the exceptions already stated, have not been without drought. Have the favoured districts been the *interior* of Clarendon, Saint James, Hanover, and the *wholly inland* ones of Saint John and Saint Thomas in the Vale? We are in doubt, as the Returns do not particularize districts, and we are wholly left to conjecture, and led to ask, are these seasonable districts securely guarded by natural obstacles which deter the approach of man? or are they only accessible by means of difficult ascent, over dangerous foot-tracks where neither quadruped nor carriage can find a way? We are inclined to infer the one or the other, which alone may have spared them from the woodman's axe.

"This drought, which may be the forerunner of dearth, is a subject for deep thought, it is not single, but concerns and belongs to all, whether of the upper class or of the lower class; its effects will not be partial but universal, and each and every one will feel the stroke; it behoves us, therefore, at once to consider the subject, to endeavour to discover its cause, and if powerless at present to avert it, to endeavour to provide against it for the future.

"We have heard it said often, by old stagers, that the seasons have changed, and they do not visit us with the same severity as in days gone by, but we have never heard any testify, till of late years, to the *absence* of seasons. In 1840, as appears by the Jamaica Almanac, the Island suffered severely from want of rains, an event that the two preceding years of the state of society would naturally have produced, and which, to the observant man, would have been like the hand-writing on the wall. In 1838 the birth of freedom to the apprentices was ushered in, not with promises of help, nor educational aid by those who exacted their former unrequited services, but by the destruction of houses, cocoanut groves, and other fruits planted and nurtured by the peasants, the wholesale destruction on settled properties produced its effects; but greater still were they in remoter districts in the fastnesses of the mountains, where the peasantry sought for homes, extensive tracts of land were laid bare by means of the axe and fire. Without foliage to arrest moisture, few districts where emancipation villages were settled escaped the severity of drought, which was at its height in 1840; however, the negro, more thoughtful than his superior, when he removed one tree, took means to have it immediately succeeded by one or more of a valuable sort. Nature soon recovers herself, and in a few years improvement in the seasons became visible, until finally, in 1869, the change for the worse was too visible to escape observation, and has year by year continued to the present period.

"To what cause are we to ascribe this lack of rainfall in this former 'land of springs'? Is it henceforward remediable? If we will be governed by the teachings of those who have studied the subject, and allow ourselves to profit by their experience, observation, and practice, the cause and the remedy are no mysteries.

"It had been well ascertained, years ago, that the cutting down of trees 'diminishes the amount of rainfall, and that fertility depends essentially upon this—that trees play an important part in the economy of nature, and furnish natural barriers against sudden floods, their roots penetrating the soil form a sort of sponge which absorbs the rainfall, causing it to pass off gradually instead of a sudden torrent sweeping away the soil.' This latter is a truism which I am forced to admit, having outward and visible signs in the barrenness of herbage in denuded fields, and I presume *my* experience has extended to many others. If we admit the fact, for fact it is, that the cutting down of trees diminishes the amount of rainfall, then it will be our duty to discover how tree destruction has occasioned diminished moisture, and when, and if it progresses with equal steps the one with the other, that is, that tree destruction has been succeeded by diminished rain falls.

"In a lowland district hitherto seasonable, but where large drafts of fuel-wood had been made leaving treeless fields, and where a record of the rainfall had been noted for many years, the decrease began some years before 1868, but in that year it was observed that we had only slight showers and no pond rains; in 1869 one-third less number of showers with one pond rain; in 1870 with an increased number of slight showers distributed in unusual months, with a continuous fall for thirty days in October, (from the 2nd to the 7th it rained pond rains as if they were bidding us farewell); in 1871 half the showers of 1870, distributed in slight showers in months formerly called '*dry*,' while in January, May, and June, no rain fell at all, but, quite unusual, February was blessed with a pond rain; in 1872 a similar decrease is recorded with one pond rain in March, another unusual month, and one in May with five slight showers in all that month, and four of an average duration of about five minutes each for all the month of October, and in 1873, what had not happened for fifteen years before, there fell a pond rain in January.

"Now, here it is patent that the decrease of rainfall began with the cutting down of trees, and although the number of rainfalls have sometimes been in slight excess one year over another, yet, the quantity was less; it is unfortunate that no pluviometer was at hand to mark the quantity, but we can well estimate it by its duration in time; but this, it will be said, is only true of one district, and we cannot deduce a universal conclusion from a particular premiss. Granted, we will proceed farther. Judging that like causes produce like effects, and fearing that the increased demand of trade for logwood would unmistakeably leave a desolating mark on the future of Jamaica, I wrote an article on the subject some two or three years ago, which the editor of the *County Union* did me the honour to have published in his paper, and I then predicted what is now occurring, and suggested the immediate planting of trees of quick growth to replace the logwood removed. My predictions have been fully verified for nearly the whole Island, by the Returns furnished by the Collector General which we will shortly epitomize:—

| | |
|---|---|
| In 1868 | 88,363 |
| 1869 | 107,634 |
| 1870 | 112,392 |
| 1871 | 60,152 |
| 1872 | 82,292 |

Tons of fustic, logwood, lignum vitæ, bitter wood, ebony, and candle wood, together with

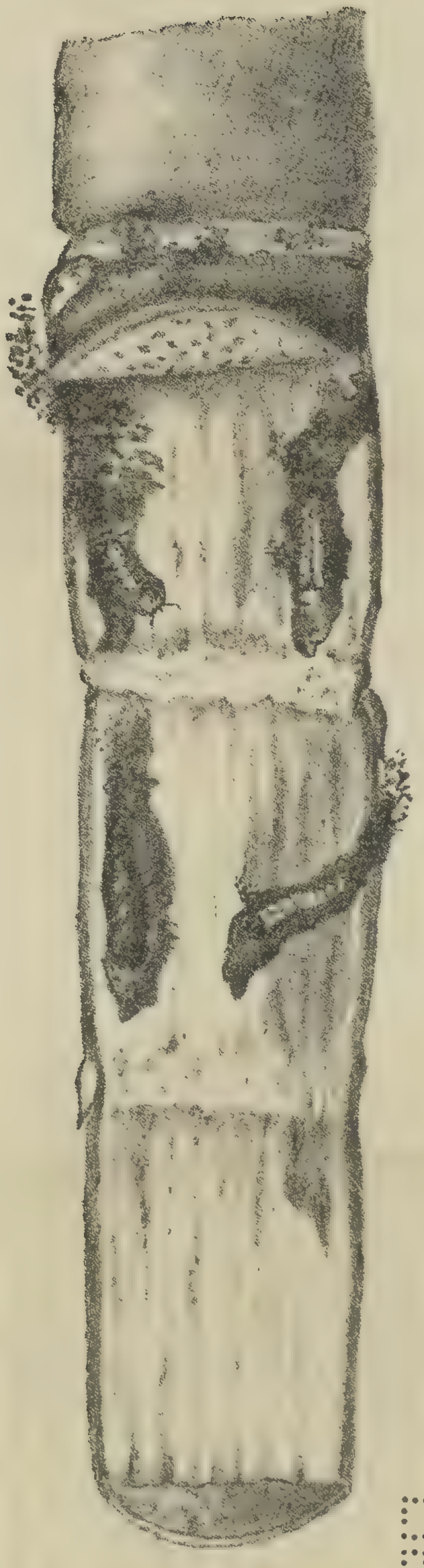
24,118 lancewood spars,
41,336 feet mahogany,
530 tons } bamboo,
10,084 bundles }

were cut and shipped from this Island in the five years mentioned above. To arrive at some conjectural estimate of the number of trees thus destroyed, we must not be content with the above, but must add thereto the home consumption for fuel, furniture, building and other purposes. Would it be too much to rate this at about 1-50th of the above, or in round numbers say 10,000? We will then have 460,833 tons of wood; considering that ebony, candle wood, bitter wood, fustic, and lignum vitæ are not trees of such large diameter as the logwood, it will not be in excess to average each ton as causing the destruction of five trees. This, without including lance wood, &c., will amount to upwards of two millions of trees removed from off the face of the land in five years. What would have been the immediate condition of a country of half the extent of Jamaica by such a removal in five years? If we had not reliable authority in addition to acquaint us with the almost universal drought in this Island, the fact of such a large removal of foliage would, from experience, have predicated it, for, 'besides acting as regulators, forests have much to do in deciding the absolute amount of rainfall. The cool foliage of a great tree condenses the atmospheric moisture which would otherwise pass on with the aerial currents.' This is the general assertion, and being stated in general terms the mind cannot determine a quantitative result, but only recognize the fact. If uncertainty lingers here, experimental facts dispel the doubt and conclusively settle the question. Mons. Pfaff ascertained by experiment that the evaporation of the surface of the leaves of a small oak consisting of 620,464 on an average of fourteen days in May was nearly 884 kilog.; for the whole of June 26,023 kilog., and for October 17,023 : a kilgogramme, it may be added, is equal to 2 lbs. 3 ozs.—(*The Gardener's Chronicle*, 1872, page 904.) If this be the amount of evaporation from the leaves of a small tree, what must it have been from the uncountable billions removed by cutting down of two millions of trees. Had they been growing, some of the evaporation would have been arrested by cold currents of air in the upper regions, condensed and returned to us in the shape of rain, and not wholly 'have passed on with the aerial currents.' *We* are at the commencement of our troubles: the Island of Santa Cruz is at full tide in hers. A Bulletin of the Torrey Botanical Club, published in the *Gardener's Chronicle* of the 3rd May, announced the deplorable desiccation of that once fertile Island, which, with the adjacent smaller ones, 'were in former times clothed with dense forests, and their oldest inhabitants remember when the rains were abundant, and the hills and all uncultivated places were shaded by extensive groves. The removal of trees was certainly the cause of the present evil. The opening of soil to the vertical sun rapidly dries up the moisture, and prevents rain from sinking to the roots of plants. The rainy seasons in these climates are not continuous cloudy days, but succession of sudden showers, with the sun shining hot in the intervals.' This has also been our experience for some time. The evil is said to be, that every few years an estate, formerly green with canefields, becoming incapable of producing further crops, has to be abandoned to the graziers, whose cattle find a meagre pasture upon it a few seasons longer. These are in time driven off and the land is entirely given up—cultivation is impossible without constant irrigation. Some attempts were at one time made to arrest this insidious advance, but too late to be effectual. A planter not long since set out 1000 trees upon his estate, and lost every one. It is probable that had this remedy been universally adopted in time there might be a more hopeful future for Santa Cruz.' We will only make one more quotation justifying the opinion of the writer as to the cause of the sterility, contrasting Santa Cruz with Porto-Rico which lies about 50 miles westward, and in the same parallel where 'the land is almost wholly mountainous, the eastern ridges rising to 3000 feet; a large portion of the interior is still covered with primitive forest; a tangled tropical vegetation of vivid perennial verdure. The rainfall is abundant, and the soil yields bountiful crops of coffee and sugar, with a great variety of fruits.'

"Many an illiterate but observant peasant will confirm the tale of the 'old inhabitants' of Santa Cruz as producing like results in Jamaica. Enquire of many why the rains are not as before, or why a spring has failed? and the reply will be, 'No, since dem cut down de tree, dem pon hill top, and since dem clear wa de wood from de pring de rain top, and de water gone wa.'

"The Island of Mauritius, too, has paid the penalty due to its avarice; in its greed to increase sugar cultivation innumerable trees have been destroyed, and the result has been so disastrous that public attention is now being aroused to the state of that Island.

"The foregoing facts most unmistakeably disclose the cause of Jamaica's present condition, and warns us from the state of Santa Cruz to take means to prevent our falling into the same misfortune in which she now lies. The immediate remedy for the evil would



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be in preventive measures, but these can never be introduced in a free Government. We must then resort to auxiliary and subsidiary means—we must show men where their interest lies—we must work upon their parental affection, by showing them that present wealth to them will be poverty to their posterity, and finally we must inculcate in them the obligation to 'serve and wait.' Some countries have been like us, and have recovered; others have taken time by the forelock, and by prohibitory legislation have avoided the evil; let *us* profit by their experience and follow in part their example. Ibrahim Pacha in the former rainless region of the Delta, by the planting of twenty millions of trees after a time obtained forty inches of rainfall which annually increases.

"In some parts of Natal formerly dry, the planting and rearing of the gum tree of Australia (Eucalyptus) which grows to a height of thirty feet in three years, has improved the rainfall considerably."

## CANE BORER.

Each segment has four black glands in a longitudinal row on each side of the back, marked by a pink band—on the lateral sides are also seen eight black points surrounded by glands of the same color united also by a pink band—these points are the stigmata or openings through which air is admitted into the tracheæ, or organs of respiration. The glands are generally terminated with bristles.

We have noticed that the caterpillar changes its skin five times before its metamorphosis. It is a laborious work during which many caterpillars must lose their lives. When it has just undergone this change, the insect is white and so transparent that the tracheæ may be seen through the skin as well as the digestive organ, and the passage of the food through the intestines; but it soon recovers its natural appearance and colour.

When the caterpillar has reached the required age to transform itself into Chrysalis, it leaves the interior of the cane where it has fed and developed itself and tries to conceal itself among the dried leaves of the plant, which it unites but feebly with a few silken threads, and collects a few remains of the leaf with which it builds a slight covering, under which it transforms itself. Observation has shewn us that all caterpillars, through want of foresight or otherwise had not provided an easy egress out of the cane, and were obliged to undergo their metamorphosis within it, were in danger of perishing either by excess of humidity, or they were devoured by the Acares, which also live upon the sugar cane, and which know full well how to find these out. This fact has been sufficiently demonstrated by the examination of several hundred chrysalis obtained from the interior of the cane, and which instead of containing butterflies, were filled with Acares.

We have further to speak of another butterfly, indigenous in Mauritius, the caterpillar of which does not attack sound canes as does the *Proceras;* indeed, we have only met it in fields where the canes were rotten, and in other plants in the same state. As this insect has always existed in our Island, and as it had never been noticed that it was hurtful to the sugar cane, we do not feel called upon to give a complete description of its habits and characteristics; we shall simply state that, this insect belongs to the great family of Moths, and that it forms the genus *Alucite* of Lamark, or *Ypsolophus* of Fabricius.

As far as the committee have been able to ascertain the fact, the duration of all the transformations of this insect, from the deposit of the eggs to the future generation comprises about sixty days. It may be observed that this period can only be fixed approximately, in as much as these observations were made on individuals kept in captivity, and that, in such cases, the transformation may be accelerated or retarded a few days.

The only butterfly of which the laying has been well observed, has deposited 162 ova during its existence, which lasted three or four days—several of the eggs may have been lost; those observed were deposited on two parallel and regular lines, and hatched on the ninth day.

These ova are transparent, their greenish colour makes it difficult to distinguish them from the cane leaf, on which they are in preference deposited by the female insect; they are depressed and oval, their largest diameter may be one-third of a line.

The transparency of the ovoidal envelope has permitted with the assistance of a microscope, to follow day by day and almost hour by hour, the progress of the formation of the caterpillar in the egg,

On the second day an opaque line was noticed, which indicates the first rudiment of the digestive organ. The next day a small black point was seen at one of the extremities of that line, indicated the head.

Later, and as the middle line increases in size, the body of the insect becomes gradually of a darker colour and more apparent, its movements soon become visible, and its position was that of a reptile coiled upon itself, with the head in the centre. At last on the ninth day, the young caterpillar quickly threw off its envelope, and moved about with vivacity. It began immediately to spin a very fine silken thread, that it attaches first on one side, then on the other, so as to conceal and shelter itself between the young leaves, where it penetrates under the parenchyma of the leaf.

The length of the caterpillar on coming out of its shell, is about 1½ line, at the end of thirty-one or thirty-two days, it generally attains the size of a small quill, and is about 12 or 14 lines in length. It then begins to prepare its covering, if placed under favourable circumstances.

The existence of the insect in the chrysalis state may be computed at fifteen days, which added to the nine days in the egg, to the thirty-one days as a caterpillar, and to the four or five days as a butterfly, complete sixty days, as we have already stated for the total period of its transformations.

It follows therefore, that a new generation takes place almost every two months, and that we may reckon five or six of them a year. It would be necessary to organise a general chase, during the whole period of a generation, to accomplish a complete destruction of the genus; unfortunately on account of the mildness of our climate, it appears that reproduction takes place at all periods of the year. We have found at the same time insects in their various stages of transformation; nevertheless, the large number of chrysalis found in the month of September would lead us to believe, that it is principally in July and August, that the deposit of ova takes place.

We have been able to ascertain that it is among the green leaves of the cane that this deposit is made, and that the young caterpillars are found on the healthy canes at the axils of the leaves. This rule is not, however, invariable, because some are also found on dead pieces of cane without leaves.

In the first case, the disorganized state of the cane plant is apparent, and the young insect may sometimes be seen at work under the parenchyma, destroying the cellular tissue of the leaf, and when stronger, it attacks the cane plant itself in the tender parts within reach. When it introduces itself into the heart, boring longitudinally, the cane plant languishes and dies. If on the contrary, the cane is attacked transversely in a stronger part, it appears to suffer in a less degree; in addition to the direct injury caused by the borer, a fermentation more or less extensive takes place in all the injured parts; the cane, however, continues to grow. It may reasonably be inferred that the ova are not deposited in the interior of the cane, from the fact that all the insects found within it, had already acquired a certain development. Chrysalis are often found within the cane, but most frequently, as we have already stated, the caterpillars abandon the interior of the cane to undergo their last transformation amongst the rolled up leaves.

What we have stated respecting the habits, and the successive transformations of the borer, appear sufficient to guide us in the study of the practical and efficacious measures required to arrive at its destruction.

We have still, however, to examine whether nature has not raised against it some powerful enemy, whose assistance might be useful; when deprived of the protection afforded by the cane, and of the shelter of its leaves, it is certain that the borer can be successfully attacked by a great number of natural enemies. We have even noticed that it perishes when left for sometime uncovered and unprotected. This fact clearly demonstrates the necessity of removing the straw or dead leaves from all plantations where the borer exists, and of burning or carrying every thing away from the fields recently cut.

We have remarked amongst the various kinds of insects, that the ant wages a successful war against the borer. All species of ants appear to attack it with the same spirit; the minuteness of this enemy as well as its indefatigable activity, enable it to penetrate into all places where the borer may conceal itself. We feel convinced in consequence, that the ants destroy a large number of eggs, caterpillars and butterflies. They penetrated into glass vessels, where several Members of the Committee had placed insects in these various stages, and the ants devoured them.

When at liberty a single ant has been seen attacking a borer, and almost invariably got the better of it, with the assistance of two or three companions. A species of acares also destroy a number of chrysalis; those particularly within the interior of the cane.

It appears unfortunately that this destruction is only partial, and therefore insufficient, since in spite of ants and acares the propagation of the borer has always been increasing.

We ought not then to reckon upon other auxiliaries, we must find out and apply ourselves the means of destruction.

The first that presents itself among all remedial measures is getting rid in a direct manner of the caterpillars, but as it is not possible to do so upon a large scale, and that to arrive at this operation it would be necessary to injure the cane more than does the insect, this process must be given up; however, we are of opinion that a careful planter who would teach a few intelligent men how to recognise amongst young canes those plants that are attacked by the borer, and who would order these plants to be cut off with a sharp instrument, might succeed in saving plantations when only slightly attacked. Burning appears to us the only means of operating upon a large scale, and of being susceptible of a sure and complete result, provided it be applied with perseverance, intelligence, and unity of purpose.

Suffocation by the fumes of sulphur, iodine, &c., or by the smoke of certain plants, such for instance as the wild tobacco, would be attended with some danger, and does not appear to us practical or sufficiently efficacious against an enemy which is not easily affected by these applications, and which is almost entirely protected against them in its inner habitation.

As to poisoning by the vegetative absorption of the plant, we do not see what substance could be used without injury to the juice of the sugar cane; the remedy would then be worse than the evil. The experiments tried have not proved satisfactory. In spite of prolonged absorption by pieces of cane placed in solutions of iodine and hydrosulphuric acid, the insect has continued to live in these without appearing the least affected; the absorption of water charged with hydrochloric acid gas has killed the insect, but it first destroyed the cane.

We believe that the result of electricity would be similar, and that besides the difficulty of applying it to 20, 30, or 40,000 canes contained in a single acre, it would not be efficacious against the insect living within the cane, unless the plant itself be blasted. There remains the use of fire by burning all parts of the cane which do not pass through the mill. This remedy appears to us *quite practical*, *relatively easy*, and *quite certain*, provided it be applied, as already stated, with perseverance, intelligence, and unity of purpose.

We say: 1st. That this remedy is *quite practical*. Because all ripe canes are cut every year, and that it is advantageous to burn either on the field, as a powerful manure, or in the furnace as fuel, all parts of the cane which have not passed through the mill.

2nd. That it is *relatively easy*. Because it is the most economical and the most easily applied of all the remedies suggested; and that the trouble is immediately repaid by the cleaning which this burning gives to the field, and by the ashes which fertilize the ground.

3rd. That it is *quite certain*. Because the mill crushing all the insects which are in the canes, the fire completes the destruction of the eggs, caterpillars, chrysalis and butterflies which are in the other parts, left on the field, that is to say, in the tops, leaves, and dry straw, which have fallen on the ground.

But we have said that this remedy must be applied with intelligence, perseverance, and unity of purpose.

With *intelligence*. For it is necessary to wait until the straw is dry enough to burn well; it is necessary to collect all the remains to burn them completely a second and a third time, or carry them to the furnace. It is not advisable to delay this operation long enough to allow the caterpillars to seek refuge in the next field, or give time to the chrysalis to become butterfly. Lastly, contrary to our first opinion, based upon the known habits of most butterflies of the nocturn family, it is not advisable to burn at night, for it appears from the study that we have made, as we have already stated, that this butterfly is sedentary and almost blind, and that it can be destroyed by fire during the day, it attempts on the contrary to fly away from a vivid light during night. In short, we think it advisable that burning should take place four days after the cutting of each square of canes.

With *perseverance*. Because it would suffice that a few insects escape from the burning of each square, to render it impossible the total destruction of the borer in one, two, or even three years. But the number will certainly be greatly reduced from the first year.

With *unity of purpose*. Because it would almost be useless for a planter to burn the canes of a square if he neglects burning the others, even the abandoned fields; for in such are found proportionately more caterpillars than in the cultivated fields, and we call the special attention of planters to the fact, that the stumps of canes left on the ground swarm with borers. It would indeed be particularly useless for careful cultivators to burn their cane straw and stumps, if others, by obstinacy, neglect, or false calculation were not to burn likewise.

The accompanying lithograph represents the summit of a cane split longitudinally, showing how the borers are lodged within. They are in part disengaged from the temporary shelter prepared with the remains of the cane and with the refuse of digestion, and which they unite by means of a few silken threads.

## ESTATE EXPENSES IN PORTO-RICO.

Cost of planting and cultivating one acre of canes, which on an average of the whole cultivation yields four hogsheads of sugar. 5,600 lbs. sugar, 170 wine gallons molasses.

| | Per acre. | Per hhd. | Total. |
|---|---|---|---|
| | Dols. c. | | |
| Preparing the land for ploughing ........ | 2 25 | | |
| 1st, 2nd, and 3rd ploughing .............. | 14 0 | | |
| Liming, &c. ........................... | 0 50 | | |
| Furrowing and subsoiling furrows ........ | 3 0 | | |
| Planting, "plants and cartage" .... ..... | 3 50 | | |
| Trenches for irrigation, 5 acres at 75 c. .... | 3 75 | | |
| ,, 4 acres ...................... | 4 0 | | |
| 1st and 2nd weeding .................... | 5 0 | | |
| 3rd and 4th ,, .................... | 4 0 | | |
| 5th and 6th ,, .................... | 2 50 | | |
| Total cultivation ................ | 43 0 | 10 75 | |
| ,, manufacture ...................... | | 5 43 | |
| Hhd. .................................. | | 4 0 | |
| Cartage .............................. | | 1 0 | |
| Taxes, direct and indirect ................ | | 7 50 | |
| Division of general estate expenses ........... | | 6 33 | |
| | | | Dols. 35 |

Ploughing done by men with their own cattle. If estate cattle are used, taking interest on capital employed, &c., it costs about the same.

Result in the Curing House, and on the pay list of work done on an estate in Ponce, Porto-Rico, being the average work. Mill working 4½ days 3½ nights.

Result—40 hhds sugar,
56,000 lbs. dry sugar,
1,720 wine gallons molasses.

| | Expenses in Works. | Day. | Night. | Total. | P. hhd. |
|---|---|---|---|---|---|
| 6 | Men herding canes to carriers .. | 12·50 | 10·50 | | |
| 1 | Feeding mill ................. | 2·25 | 1·75 | | |
| 1 | Green megass cart............ | 2·25 | 1·75 | | |
| 1 | Attending engine ............ | 2·25 | 1·75 | | |
| 1 | Attending sulphurous gas...... | 1·12½ | 1·75 | | |
| 4 | Boiler men.................. | 9·0 | 7·0 | | |
| 1 | Cleaning strainer ........... | 1·12½ | 1·75 | | |
| 2 | Firemen .................... | 4·50 | 3·87 | | |
| 3 | With dry megass cart, &c. .... | 6·75 | 5·25 | | |
| 1 | Dry trash .................. | 2·25 | 1·75 | | |
| 21 | Total ...................... | 46·20 | 37·12 | 83·32 | 2·08 |
| | Cane cutting ..................... | | | 60·87 | 1·52 |
| | Carting .......................... | | | 62·0 | 1·55 |
| 16 | Employed one day potting .............. | | | 8·0 | 0·20 |
| | | | | | Dols. 5 35 |

P.S.—Four open coppers to the battery, and a wooden bin containing a set of tubes making a steam teche for striking point; also using Colonel Stewart's system of sulphurous gas, as a deficator and clarifier of the cane juice as it comes from the mill.

Result in the curing house, and on the pay list of work done on an estate in Ponce, Porto-Rico, being the average work. Mill working 5 days and 3½ nights.

Result—45 hhds. sugar,
63,000 lbs. sugar,
2,000 gallons "wine" molasses.

| | Expenses in the Works. | Day. | Night. |
|---|---|---|---|
| | | Dols. c. | |
| 6 | Persons as cane carriers ...... | 15·0 | 14·0 |
| 1 | Feeding mill ................ | 2·50 | 1·75 |
| 1 | With green megass cart ...... | 2·50 | 1·75 |
| 1 | Attending engine ............ | 2·50 | 1·75 |
| 4 | Boiler men.................. | 10·0 | 7·0 |
| 1 | Attending sulphurous gas app... | 1·25 | 1·75 |
| 2 | Firemen .................... | 5·0 | 4·50 |

| | Expenses in the Works. | Day.<br>Dols. c. | Night. | Total. | P. hhd. |
|---|---|---|---|---|---|
| 3 | With dry megass cart, &c. .... | 5·0 | 5·25 | | |
| 1 | With dry trash .............. | 2·50 | 2·75 | | |
| 1 | Cleaning about copper hole, &c.. | 2·50 | 1·75 | | |
| 22 | Total ...................... | 50·0 | 44·0 | 94·0 | 2.08 |
| | Cane cutting .............................. | | | 70· | 1·55 |
| | Carting .................................. | | | 75· | 1·66 |
| 18 | Employed one day potting ....... ........ | | | 9·0 | 0·20 |
| | | | | Dols. | 5·49 |

At night 8 people more employed as cane carriers. These two tests represent about the general run of work; they are taken by hazard, one in the month of May, one in June, in fact, this is last week's work.

Crop for 1872 of an estate in Ponce, Porto-Rico. 130 acres plant canes, well irrigated, produced

10,515,960 lbs. cane,
625,950 imperial galls. cane juice,
670,570 lbs. dry sugar sold,
235,480 lbs. molasses sold, supposing 11 lbs. to the wine gallon, the measure used here.

Besides sugar and molasses used freely on the estate, during the twelve months, both for people and stock.

## ON EXPERIMENTS WITH MANURES IN THE WEST INDIES.

By T. L. Phipson, Ph.D., F.C.S.,

*Corresponding Member of the Chemical Society of Paris, &c.*

For some years past I have given in this journal the results of a somewhat prolonged investigation of the cane soils of British Guiana and the West India Islands, and I have since condensed the principal facts in a pamphlet, which has been recently noticed in these pages; perhaps I may be allowed to take this opportunity of thanking the writer of that review, and the editors of various other periodicals, for the very kind and indulgent manner in which they have alluded to my imperfect efforts to throw some light upon a most obscure and difficult question.

Our Demerara planters want 2 to 3 hhds. of sugar *per acre*, and are getting from 1 to 2—very rarely 2. The manures experimented with occasionally succeed, and still oftener fail to produce the desired results. The experiments are made in such a manner that they can teach no practical lesson. Let us examine how this is. Let us glance at the kind of information we get handed to us in London or Liverpool, for instance, after we have bestowed considerable time, pains, and money, to ascertain the kind of manure best suited to soils which have been submitted to the most rigorous chemical investigation.

Many of my readers will recollect the strong arguments used in favour of the natural manure prepared at Bloxwitch, in Staffordshire, especially for the cane soils of the West Indies, known as the Urban cane manure. Now what kind of accounts do we hear of it. A. reports that his crops have been splendid, that it is the best manure he ever used, and requests that a much larger quantity be sent out at once. B. reports that it has produced no results at all, and begs that no more may be sent out! Truly this is perplexing. How are we to solve this enigma—an enigma, be it understood, that applies to almost every agricultural experiment that has been made in our Colonies? First of all let it be borne in mind that the Urban cane manure is not a mere theoretical idea; it has given in this country the most prolific results, and was reported on by the highest authorities before it was recommended for the cane; and there is no apparent reason why it should give an excellent result in one case and none whatever in another. I have arrived, however, at three conclusions *with regard to certain negative* accounts forwarded from Demerara to owners of estates there, which may prove useful to many of the readers of this periodical.

1. There is great difficulty in getting here a thoroughly unbiassed report upon the effects produced by any kind of manure; and it is

still more difficult to ensure out there a fair trial of any manure hitherto unknown.

2. The Urban cane manure applied to lands in England where wheat is grown has always given the best results on those lands which were most carefully cultivated, and in the West Indies it has also given the best results in those localities where labour is most abundant, in other terms where the canes received a proper amount of tillage.

3. In most cases the experiments with manures appear to have been made with the most reckless carelessness, both as to the yield and the cost of the application, and are not capable of throwing the smallest light upon the question at issue.

Let us take, for instance, the following report recently forwarded to me by a gentleman, for whose opinion I have great respect, and who is as anxious as myself that an economical means of increasing the fertility of our cane soils should be found. Allow me to ask how is he, or anyone else, to draw any conclusion from the following report of last season's experiments received from his agent in Demerara:—

| Quantity and nature of manure employed per acre. | Produce per acre. |
|---|---|
| 3 cwt. sulphate of ammonia ........................ | $1\frac{7}{16}$ hhds. |
| 2 cwt. sulphate of ammonia ........................ | $1\frac{7}{8}$ ,, |
| Not manured at all .................................. | $1\frac{6}{7}$ ,, |
| 2 cwt. sulphate of ammonia and phospho-guano mixed.. | $1\frac{3}{7}$ ,, |

Not only are the various manures taken in unequal quantities, but in *unequal money-values*, so that the trial is unfair in every way to the makers of the various manures experimented with. In the next place we have the perplexing fact that 3 cwt. of one manure gave a smaller result than 2 cwt. of the same stuff, whilst *no manure at all* gave almost the best result recorded. The above figures are merely extracted from a much larger number, by way for example—3 cwt. of sulphate of ammonia, costing at the time it was applied about £3 3s., would pay for 7 to 8 cwt. of Urban cane manure, and 6 cwt. of the latter per acre has yielded rather over 2 hhds. of sugar.

The ingenious author of some excellent papers published in this journal, M. Krajenbrink, referring to his experiments in Java, got 5,000lbs. of crystallized sugar to the acre. He says: "The canes were planted in rows about 5 feet apart, each row 86 yards in length. The plants were placed near together, and were all uniformly treated with farm yard manure, a basket to each yard in length of the row, about 30 cart loads to the acre, which was earthed in by hand labour. Every care was taken of the canes during their growth, and after the second hoeing they were manured with a small quantity each of ground oil cake."

Now 30 cart loads of *good* farm yard manure is equal to about 10 cart loads of Urban cane manure, or to 6 or 7 cart loads if the former is only moderately rich. But who has ever used so much to the acre? not to mention the supplementary dose of ground oil cake. No wonder, however, that this writer should have assured himself (as I had done already some time previously) of one fact which I also give in his own words: "The conclusion that may be already drawn from my labours is that it would be possible, by a more abundant use of manure, *to double the produce we obtain from the cane.*"

I have once before alluded to the great deception we encourage in judging of the action of any manure by the yield of sugar only. Planters say it is all we look for. Very true, but three things are necessary to enable you to judge how your manure has acted:—

1. The yield in weight of canes for a given surface.

2. The proportionate quantity of juice extracted from the canes; and,

3. The quantity of crystallized sugar contained in the juice.

Unless these three data are taken simultaneously into account no conclusion whatever can be arrived at. Nothing is more simple, or more true. Yet who does take them into consideration? Who knows, here in London, whether his manager or his manure is the cause of his not getting his 2 hhds. of sugar to the acre? Again, in comparing the effects of different manures, who is to draw a conclusion when £100 worth of one kind of stuff is used against £30 worth of another?

But we are losing sight of the most important fact of all, namely that imperfect manures or stimulants, though they may give a brilliant result for one or two seasons, or even longer, will eventually exhaust the soil of the estate.

## ENQUIRY INTO THE USE OF THE SACCHARIMETER, AND OF CHEMICAL ANALYSIS FOR THE ANALYSIS OF RAW SUGARS.

(*Continued from page* 378.)

### Question III.

*Is the saccharimeter adopted in commerce always sufficient for an exact determination of the value of raw and refined sugars?*

#### Answers.

M. Angenot, Antwerp. The saccharimeter, as now adopted in commerce, is not free from faults.

In order to obtain an exact determination of the value of raw and refined sugar more is necessary than merely to determine the amount of saccharine richness, as the sugar always contains besides this, moisture, mineral salts and organic matter.

The salts (or ash remaining after incineration) as well as the glucose, prevent a certain amount of sugar from crystallizing, thus rendering the production of refined sugar less than the amount of pure sugar present. In practice it is considered that if a sugar has given a certain weight of ash on incineration — say 2 per cent. — the salts which are to compose this 2 per cent of ash prevent the crystallization of five times their weight of sugar.

From this it is evident that raw sugar titrating 95 per cent. of pure sugar, will on being refined only give $95 - (5 \times 2) = 85$ of refined sugar. This is what is termed multiplying the weight of ash by the coefficient 5.

Nevertheless experience has shown that in reality the salts do not prevent the crystallization of five times their weight of sugar, as certain salts are less melassigenous than others. The coefficient appears to be 3·6 as M. Wonssen shows very clearly in his *brochure* entitled "*De l'analyse des sucres*" (annexed to the report of the Central Committee of Sugar Refiners of July 20th, 1871. Brussels: Mayolez. p. 39.) It would thus be desirable that 3·6 should be adopted as the coefficient, an appreciation sufficiently near the actual production would thus be arrived at. The coefficient is merely conventional, and is not the result of practical experience.

M. Boyard, Brussels. In order to determine exactly the value of raw sugars it is necessary to know:—

1st. The amount of crystallizable sugar they contain.

2nd. The produce of this sugar on refining.

The saccharimeter gives an exact determination of the amount of crystallizable sugar in raw sugar. The produce on refining is calculated from the amount of ash contained in raw sugar. It is known that 1 part of ash hinders (in refining) the crystallization of 5 parts of sugar. Then deduct from the amount of crystallizable sugar, as shown by the saccharimeter the weight of ash multiplied by 5.

This is not the place to discuss the value of the coefficient 5. It is nevertheless well to say that the analysis of molasses of the refining shows that as a general rule the proportion of salts to sugar is as 1 to 5. The average composition of molasses is as 15 parts of sugar to 10 parts of salts. However this proportion may sensibly diminish, according to the method of refining and the means employed in the work.

In Germany sugars are purchased according to the polarimetric degree only. German chemists are of the opinion, that in order to determine the refinable produce of a raw sugar, notice must be taken of the amount of organic matter which the sugar contains, and not to go entirely by their richness in salts, for although some of the salts in sugar are, it is true, prejudicial to crystallization, others have an indifferent or neutral effect, whilst certain salts on the contrary favour crystallization.

M. de Koninck, Liége. The saccharimetrical method adopted by commerce and spoken of in the answer to the previous question, would, in all cases give a sufficiently exact idea of the amount of crystallizable sugar in a raw sugar. The only substances which, being present in sugar, might falsify the experimental results, are non-commercial products and much too costly for fear of fraud being committed by their means.

If Government decides on basing the tax in a manner that would be rational from the stand point of the sugar industry,—not on the amount of crystallizable sugar present, but upon the produce calculated as is done in commerce, it would help to prevent that species of fraud which consists in adding to the sugar *insoluble inorganic matter*, such as chalk, plaster, clay or sand, the only things it would be to their interest to add to it, as, without prejudice to the quality of the production, they would increase the proportion of ash, and would have consequently a great influence on the calculated production without having any influence on the real production.

To prepare for this possibility, it would be sufficient to come to the understanding that matters *insoluble in water* would not be considered as ash. There would be no difficulty in separating them and determining their amount.

M. Donny, Ghent. The optical saccharimeter is sufficient to determine the amount of pure sugar contained in raw sugar. But it is not always sufficient for determining the production of the same sugar. Thus, two sugars containing the same quantity of pure sugar might give different amounts of produce when refined, according to the nature of the impurities which the raw sugars contained.

M. Dufour, Antwerp. The optical saccharimeter is always sufficient for the exact determination of raw sugars, provided the examination is made on the solutions decolorized and freed from foreign substances which might have an influence on polarized light. But the methods of manufacture and refining, now in use, do not show the method of obtaining from raw sugars the amount of real sugar which they contain. This is an important point, and one to which regard should be had in the interests of the industry.

M. Gaillard, Tirlemont. No! seeing that the saline coefficient varies, according to the manufactories, with the quality of the first material and the method of work, and that within rather extended limits (about 3 to 5½); the figure 5, taken as the coefficient in commerce, is nearly a maximum.

M. Groulard, Liége. The determination by means of the saccharimeter of the amount of refinable sugar in raw sugar, is an exact method for as much as one admits that the coefficient 5, the basis for the calculation of production, is in itself exact. Commercial men, manufacturers, refiners, French, Belgian, English, and Dutch admit this coefficient as the basis of their transactions; whilst the Zollverein Germans have thought right to reject it and to return again and take the basis of 97 degrees polarimeter for the first production, to that of 94 degrees for the sugars of the 1st and 2nd production mixed, to that of 93 degrees for the second production as, according to them, the calculation of the production to the coefficient 5 is not placed on a scientific basis. However I have had occasion, during the present year 1872, to make a large number of analyses for Germany, all resting on the method of calculating the production to the coefficient 5, these bargains having been made on the basis of 88 degrees.

The objections which have been made to the adoption of the coefficient 5 result from this, that the works of certain chemists have shown that the proportion was too high, and should be reduced according to M. Dubrunfaut to 3·75, and according to other chemists, who, like himself, are specially engaged with the *molasses of manufacture*, should be reduced even to 3·60.

On their side, the chemists of the refineries have thought right to fix the value at 5, and the refiners, having noticed that the production in refined sugar was less than that shown by the saccharimeter in the raw sugars, by an amount represented by the weight of the ash of the same sugars multiplied by 5, have adopted this coefficient as averaging the deficit in the manufactured product.

In order to calculate exactly the produce of raw sugars in refined sugar it would be necessary to make experiments in the best organized refineries, which would permit of fixing for an actual time, the real value of the coefficient of the deficit.

In conclusion, I think it can be affirmed that if chemical analysis, such as is applied at the present time in commerce to raw sugars, does not give rigorously exact results, it is that alone which will allow the calculation, in a manner at all exact, of the probable production in refined sugar. What tends to prove the truth of this assertion is the sanction which the refining industry has given to it and the perseverance with which it preserves it.

MM. Haccour and Pauly, Antwerp. The saccharimetrical method adopted by commerce, does not always represent the percentage production of refined sugar, commerce has adopted a coefficient (the coefficient 5) whilst this coefficient varies in different manufactories.

M. Hanuise, Mons. Yes, but the coefficient 5 is not applicable in every case, in every case the coefficient 5 is always favourable to the refiner.

M. Lembourg, Quiévrain. See answer to the second question.

M. Semmell, Ghent. Quite exact, never; there is always a decided difference between two analyses of the same sugar.

M. Wachsmuth, Antwerp. The above method (analytical) is sufficient for an exact determination.

*(To be continued.)*

## MODIFICATION OF THE OPTICAL SACCHAROMETER.

By Prazmouski.

(*Comptes Rendus, lxxvi.* 1212—1214.)

It is easier for some observers to appreciate slight differences of luminous intensity than equally slight differences of tint. Frellet therefore substituted for Soleil's polarizer a rhombohedron of calc spar divided across its principal section, the two halves being re-united after removal of a prism of about 2° from each, so that the principal sections are inclined to each other at an angle of 4°. A parallelopiped thus constituted, employed as a polarizer, furnishes a field of which the two halves are alternately dark in the two positions of the analyzer.

Cornu proposed to employ a Nicol's prism cut in the same manner, but the double section is somewhat difficult to execute. Prazmouski attempted to attain the same result more simply by using with a Nicol or other analyzer, a thick plate of calcite cut parallel to its axis, and divided through the axis, its two halves being re-united after removal of a small angle of about 2° from each. The plate is placed so that the plane of division coincides with the principal section of the prism. Unfortunately the rotatory dispersion of sugar necessitates the employment of monochromatic light, for otherwise the two halves of the field are differently coloured. Prazmouski has not been successful in getting a light of sufficient intensity perfectly monochromatic, but the difficulty has been met by using Soleil's quartz compensator. These modifications may be easily introduced into instruments of the old construction.—*Journal of the Chemical Society.*

## LIQUID GLUE PREPARED FROM SACCHARATE OF LIME.

A solution of one part of loaf sugar in three parts of water, when spread on paper, imparts to it neither gloss nor strength, for the size does not adhere to the fingers when moistened. If, however, we add to the sugar the fourth part of its weight of slaked lime and warm it to 145° to 165° Faht., then let it macerate some days, shaking it frequently, we shall find the greater part of the lime dissolved. The solution decanted from the lime sediment is then found to have the properties of mucilage, and a coat of it possesses gloss and firmness. If we soak three parts of glue broken in small pieces in 12 to 15 parts of this saccharate of lime, then on warming it the glue dissolves rapidly, and remains liquid when cold without losing its strength, as glue does when treated with acid. Glue of any desirable consistency may be prepared by varying the amount of saccharate of lime added. The thicker glue keeps its muddy colour, the thin becomes clear on standing.

Gelatine dissolves in this solution of lime and sugar without previous soaking; even old gelatine which has become insoluble in hot water is soluble in this compound. This glue has great adhesiveness, and admits of very many uses. It cannot, of course, be used-on colours that are injured by the lime, as, for example, chrome-yellow, Paris-blue, zinc-green, Behringer's green, and carmine. Ponceau made from carbolic acid is changed into a beautiful carmine colour. When warming the glue to dissolve it, a strong smell of glue is given off, but this is destroyed by a few drops of oil of lavender, A small admixture of two to three per cent. of glycerine is also an advantage. Carbolic acid acts upon the lime when the glue is exposed a long time to the air, producing little white specks, without, however, affecting its adhesive and preservative power.—*Journal of Applied Chemistry.*

## Correspondence.

MANCHESTER SUGAR REFINERY.

TO THE EDITOR OF "THE SUGAR CANE."

DEAR SIR,

We doubt not that any facts relating to the important question of the comparative merits of different systems of manufacture will possess an interest for some of your readers. We therefore venture to allude to a transaction in which we have recently been engaged as buyers of sugar in the Liverpool market—and in which our experience entirely agrees with that of Messrs. Crosfield, Barrow & Co., as reported in the columns of your last number.

On August 6th we received samples of a recently landed cargo from an estate in the West Indies, the proprietors of which are well known to us as skilful and successful planters. Part of this cargo had been made into the ordinary Muscovado sugar, and the remainder into Concrete. The samples were at once analyzed, with the following results:—

| | Parts of Colour. | Crystallizable Sugar. | Glucose. | Waste. |
|---|---|---|---|---|
| 23 tierces Muscovado...... | 40 | 87·2 | 2·2 | 10·6 |
| 39 ,, ,, ...... | 90 | 84·3 | 4·4 | 11·3 |
| 37 ,, ,, ...... | 56 | 83·0 | 6·6 | 10·4 |
| 190 ,, 221 brls.,, ...... | 47 | 85·1 | 3·7 | 11·2 |
| 181 bags ,, ...... | 69 | 85·5 | 4·1 | 10·4 |
| 46 tierces Concrete ...... | 29 | 87·1 | 3·4 | 9·5 |
| 5 ,, ,, ...... | 27 | 89·4 | 2·1 | 8·5 |
| 68 bags ,, ...... | 27 | 89·5 | 2·5 | 8·0 |

The concrete was bought by us at 24s. 3d. per cwt., but the inferior analyses of the sugar prevented our advancing on the comparatively low valuations which we were compelled to put upon it, and it eventually sold at an average price of 22s. 5d. per cwt., thus making a difference of nearly 2s. in favour of the concrete. Unfortunately, we do not possess the particulars of the comparative yields, costs of production, loss by drainage, &c., to render the comparison of the two methods complete, but we can not doubt that an examination of this side of the subject would be unfavourable to the sugar. Hoping that this necessarily imperfect statement will, nevertheless, find those among the readers of your valuable journal to whom it may be of use.

We are,

Yours obediently,

Fryer, Benson & Forster.

## Stocks of Sugar in the Chief Markets of the World on the 1st July, for Three Years, in thousands of tons, to the nearest thousand.

| | 1873. | 1872. | 1871. |
|---|---|---|---|
| Great Britain | 171 | 102 | 127 |
| France | 73 | 44 | 82 |
| Holland | 61 | 4 | 23 |
| Germany (Zollverein) | 5 | 43 | 42 |
| Six other *entrepôts* | 9 | 4 | 4 |
| Total in Europe | 319 | 197 | 278 |

## Consumption of Sugar in Europe and the United States, for Three Years ending 1st July, in thousands of tons.

| | 1873. | 1872. | 1871. |
|---|---|---|---|
| Great Britain | 728 | 699 | 708 |
| France | 261 | 283 | 282 |
| Germany (Zollverein) | 261 | 206 | 219 |
| Holland | 28 | 23 | 26 |
| Six other *Entrepôts* | 104 | 94 | 106 |
| Total in Europe | 1,382 | 1,305 | 1,341 |

## Estimated Crop of Beet Root Sugar on the Continent of Europe, for the ensuing Season, compared with that of the three previous Seasons.

*(From Licht's Monthly Circular.)*

| | 1872-73.<br>Tons. | 1871-72.<br>Tons. | 1870-71.<br>Tons. | 1869-70.<br>Tons. |
|---|---|---|---|---|
| France | 395,000 | 335,000 | 289,000 | 289,000 |
| Germany (Zollverein) | 260,000 | 189,000 | 263,000 | 217,000 |
| Austro-Hungary | 205,000 | 162,000 | 182,000 | 151,000 |
| Russia and Poland | 150.000 | 90,000 | 135,000 | 133,000 |
| Belgium | 80,000 | 72.000 | 56,000 | 44,000 |
| Holland and other Countries | 35,000 | 25,000 | 17,000 | 12,000 |
| Total | 1,125,000 | 873,000 | 942,000 | 846,000 |

## SUGAR STATISTICS—GREAT BRITAIN.

To 16th August, 1872 and 1873. In Thousands of Tons, to the Nearest Thousand.

| | STOCKS. | | | | | | IMPORTS. | | | | | | DELIVERIES. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. |
| British West India | 31 | 6 | 2 | 31 | 70 | 65 | 69 | 14 | 10 | 44 | 137 | 126 | 56 | 10 | 10 | 29 | 105 | 81 |
| British East India | 14 | 2 | .. | .. | 16 | 5 | 18 | 3 | .. | .. | 21 | 13 | 13 | 4 | .. | .. | 17 | 14 |
| Mauritius ...... | 3 | 1 | .. | .. | 4 | 5 | 12 | 3 | 11 | 11 | 37 | 36 | 12 | 2 | 12 | 12 | 38 | 36 |
| Cuba .......... | 3 | 6 | 4 | 19 | 32 | 37 | 5 | 11 | 13 | 37 | 66 | 76 | 6 | 5 | 10 | 30 | 51 | 48 |
| Porto Rico, &c. .. | 2 | 11 | .. | 7 | 20 | 11 | 3 | 21 | .. | 11 | 35 | 23 | 4 | 14 | .. | 3 | 21 | 15 |
| Manilla & Java .. | 27 | 9 | .. | 2 | 38 | 15 | 22 | 8 | 7 | 6 | 43 | 37 | 15 | 5 | 6 | 8 | 34 | 45 |
| Brazil .......... | 5 | 29 | 2 | 5 | 41 | 19 | 10 | 53 | 5 | 11 | 79 | 69 | 8 | 38 | 4 | 11 | 61 | 64 |
| Beetroot, &c. .... | 2 | .. | .. | 1 | 3 | 2 | 23 | 9 | 7 | 17 | 56 | 58 | 27 | 10 | 8 | 28 | 73 | 70 |
| Total, 1873 .. | 87 | 64 | 8 | 65 | 224 | 159 | 162 | 122 | 53 | 137 | 474 | 438 | 141 | 88 | 50 | 121 | 400 | 373 |
| Total, 1872 .. | 55 | 31 | 7 | 66 | 65 increase | | 122 | 94 | 52 | 170 | 36 increase | | 106 | 89 | 50 | 128 | 27 increase | |

## STATE AND PROSPECTS OF THE SUGAR MARKET.

The raw sugar market during the past month has presented, as regards prices, a remarkable uniformity, neither rise nor fall of any considerable importance has marked its course. Refiners have been busily at work, and this circumstance has been sufficient to neutralise the effect of the steadily and rapidly increasing stock. The trade has apparently not yet ceased to feel the beneficial effects of the reduced out-put consequent upon the announcement of reduction in the duties, though we fear it may not be long before the fatal effects of Foreign subsidized competition will again be felt upon the market—or rather that their influence will again out-weigh the natural healthy tone. It must not be forgotten that the foreigner is now a still greater gainer owing to the activity of the British markets, though the disastrous consequences of his unequal position have been marked by the circumstances of a temporary prosperity.

The current price of No. 12 Havana is 27s. per cwt.; fair to good refining Cuba Muscovadoes, 21s. 6d. to 22s. 6d.; middling to good brown Bahia, 18s. to 19s. These prices, it will be noticed, show a slight advance on those of last month, particularly in the low qualities. A considerable proportion of this description has been sold for brewing.

The demand in the refined market has been large and steady—at the time of writing, however, symptoms of a lull begin to manifest themselves. The consumption for the current year up to date has been unprecedently large, being already 28,000 tons in excess of the corresponding period of 1872 for the United Kingdom.

The future of the sugar market at this time of the year is presumptively in favour of higher prices, since we have nearly reached the point when the stock generally begins to decline. Of late years, however, this tendency has been much modified by the Beet crop, of which sanguine expectations are entertained.

THE
SUGAR CANE.

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☞ The writers alone are responsible for their statements.

*For Table of Contents, see opposite the last page of each Number.*

## ON THE USE OF WET MEGASS AS FUEL.

By Alfred Fryer.

*(Continued from page* 401.)

Damp Fuel and Absorption Surface.—As the maximum temperature of the products of combustion of average dry megass is 1786° Faht., whilst that of the gases from the burning of damp megass No. 5 is only 1160° Faht., or 626° Faht. less, it might appear at the first glance, that for equal volumes of gases and equal absorption surfaces, the gases would escape into the chimney at a very much higher temperature when dry megass was used. The rate of transmission of the heat from the gases in the furnace to the metal plate whether it be steam boiler, Concretor tray, or battery, is governed, all other things being equal, by the difference in temperature of the heated gases and the heated plate. Assuming the gases to be heated to 1786° Faht., and the heated surface to be 220° Faht., and that the gases part in the first length of their course with one-sixth of the difference, their heat would be reduced on entering the second length or section by 261° Faht.

$$\frac{1786 - 220}{6} = 261° \text{ Faht.}$$

The loss of heat on reaching each section would be as under:—

Combustion of Dry Megass.—Temperature of Gases.

| | Entering. | Loss of heat in passing. |
|---|---|---|
| First section | 1786°F | 261°F |
| Second section | 1525° | 218° |
| Third section | 1307° | 181° |
| Fourth section | 1126° | 151° |
| Fifth section | 975° | 126° |
| Sixth section | 849° | 105° |
| Seventh section | 744° | 87° |
| Eighth section | 657° | 73° |

The temperature of the gases after passing eight sections, will thus have been reduced by 1202° Faht.

The cooler gases of equal volume from damp megass, passing along a similar absorbent surface, the fluid upon which is maintained at the same temperature, would part with the same proportionate quantity of their heat, namely:—

Combustion of Wet Megass.—Temperature of Gases.

| | Entering. | Loss of heat in passing. |
|---|---|---|
| First section | 1160°F | 157°F |
| Second section | 1003° | 130° |
| Third section | 873° | 109° |
| Fourth section | 764° | 91° |
| Fifth section | 673° | 75° |
| Sixth section | 598° | 63° |
| Seventh section | 535° | 53° |
| Eighth section | 482° | 44° |

The temperature of the gases in this instance, after passing eight sections, will thus have been reduced by only 722°; and thus the gases entering the chimney are within 146° Faht. of those from the combustion of the drier fuel.

But this comparison only shows the effect of burning in the same furnace an equal quantity of fibre, associated with much or little moisture. It is needful to ascertain what effect will be produced when sufficient fuels are burnt to liberate the same amount of available heat. This problem, however, is complicated by several circumstances. The most important one is, that when dry megass is used, a clear flame will impinge directly upon the absorption plate; when damp megass is used, the transmission of the heat will be due mainly to the contact of the gases. Again, when damp megass is used, the heat is diluted among a larger volume of gases and vapours; on the other hand, as their temperature is lower, they are not so much expanded as are the gases from the more intense combustion.

When it is assumed that the gases lose a definite proportion of their heat on passing along a certain length of absorbent surface it is necessary that they should move with equal velocity. The problem may be approximately solved in this manner. It has been shown that where dry fibre has been used the gases will enter the chimney at 600° after passing about 7·4 sections of surface. A pound of fibre as average dry megass will then have parted with 4262 units of heat. The gases from the combustion of a pound of fibre in the condition of damp megass No. 5 will enter the chimney at 600° after passing 5 sections of surface, and will have parted with 3212 units.

In order to ensure equal rate of absorption it is needful that the velocity should be similar, and in the case of a rectangular flue, with absorbent surface above it, as in the Concretor, it is needful that the depth of the flue be similar. Where dry megass is used it is seen that 7·4 units are sufficient for length, and where wet megass is used 5 units of length are sufficient. But in order to liberate and utilize as much heat in the latter case, four pounds of dry fibre, with its associated moisture, will require to be consumed instead of three pounds of fibre in the dry fuel, and the volume of the emerging gases from the damp megass is greater than those from the dry megass, in nearly the proportion of 5 to 3. From these data we deduce that if the flue of a furnace, such as that under the Concretor trays, is properly proportioned for the combustion of average dry megass, it will be altered to burn damp megass No. 5 (always assuming that the combustion of such fuel is perfect) by reducing its length in the proportion of 5 to 7·4, and increasing its width in the proportion of 5 to 3.

It must not be overlooked that this method of dealing with the question is far from exact or satisfactory, and though the rule of absorption of heat here adopted, is that usually employed, the experiments of the late Professor Rankine go to show that it cannot be relied upon; for at high temperatures the rate of absorption nearly approaches the square of the difference of temperature between the heating medium and the absorption surface. This circumstance will increase the efficiency of furnaces intended to burn dry megass.

Approaching the problem from another side, we find that the gases from the combustion of damp megass lose 562° in passing 5 sections of length, and the gases from that of average dry megass lose 1186° in passing 7·4 sections. Therefore, for equal quantities of gases nearly two absorbent plates, 5 sections in length, will be required for damp megass, against 1 plate 7·04 sections in length for the dry megass. But this computation will require correction, in consequence of the products of combustion from the damp fuel containing a larger proportion of water vapour, which has a high specific heat. Taking these various conditions into account, we may adopt a mean between the first form of calculation and the second, and conclude that the absorbent surface for a furnace constructed to use wet megass No. 5, should be about 30 per cent. greater than that intended for the combustion of average dry megass, both plates utilizing an equal amount of heat.

*(To be continued.)*

## ARTIFICIAL SUGAR.

In the present restless condition of the "sugar" world the following notice must have a strange effect! We are struggling to have all nations on an equality in regard to "duty;" but here we have a proposal, which, if it be true, will do away with all this restlessness, and entirely ruin most of our sugar refiners and planters! To us it seems somewhat of a humbug, but that may be only from the stupid manner in which it is stated in English.

"In order to make it, it is only necessary to bring together certain common articles, which after being liberated from the coarser elements with which they are combined, are known to have a chemical affinity to each other, and produce a sugar said to be equal to that made from cane juice or beetroot." This to us smacks of the ancient alchemistic dream of making gold! The dim, visionary manner by which the sense is obscured, if sense there be any, brings very strongly to our rememberance the writings of these olden days. If it be true, however, it is no subject for laughing at, but is a very serious one, meaning ruin to many a one. The fact that sugar would one day be built up from its constituent elements was to be expected, we have done so with many things. After analysis comes synthesis. Still, however long it might have been in coming, its advent would still have been sudden to us. The following notice is extracted from the *Engineer*:—

"Artificial Sugar.—In the French world of industry and science, great sensation has been produced by an alleged discovery, the importance of which, if it turns out to be true, it is impossible to calculate, nor the effect it may have on the sugar trade of the future. It is asserted that the French engineer, M. Jouglet, has succeeded in making artificial beetroot sugar, which, however, is not real beetroot sugar, but a composition of chemical sugar, if we may be allowed to use such a term. Already has the eminent M. Berthelot succeeded in making alcohol by a synthetic process; but the new discovery is of much more practical value, as it affects a commodity of such general use. Provided the accounts published in the French papers are not exaggerated, although such exaggeration is very likely, this new discovery may possibly bring about a change in the manufacture of sugar, for it is announced that by the new process sugar can be made not costing more than 5f. per 100 kilogrammes, or one farthing per lb.; and that in order to make it, it is only necessary to bring together certain common articles, which, after being liberated from the coarser elements with which they are combined, are known to have a chemical affinity to each other, and produce a sugar said to be equal to that made from cane juice or beetroot. Henceforward, then, the manufacture of sugar would be placed in the hands of the maker of chemicals. It is added that the discoverer, M. Jouglet, has already sold his invention to a company for the sum of 1,200,000 francs, who intend to work the invention."

## A SWEET TOOTH AND HOW TO RELIEVE IT.

"Go to the ant" is an antiquated observation, but yet by doing so we will find that this intelligent insect has a due appreciation of the value of a saccharine addition to its diet. To relieve this sweet tooth it confines a large body of slaves on sugar estates, and seems to find this slave labour satisfactory. Various naturalists have given interesting accounts of the mode in which they secured to themselves the sugary secretions—or honey dew—of the aphidae. Like more highly organized beings they have emerged from the rude hunting stage, and find it more profitable and less precarious to confine the aphis—or plant louse—on particular plants, herding their "cows" systematically, rather than allow them to wander at will like buffaloes on the prairies.

But although creatures so low in the scale of creation exhibit such marvellous intelligence in satisfying their "sweet tooth" with simplicity and ingenuity, many far more highly organized have been unable to procure this dainty so readily. In lands where the sugar-cane luxuriates naturally, or has been readily introduced, the gratification of this universal love of sweet things, founded, like most universal desires, in an omnipresent necessity, has been readily procured. Where this is not the case, mankind has found out many inventions, more or less makeshift, for supplying a substitute. Indeed, it may be said of mankind, as Emerson Tennant remarks of the aforesaid ant, that "such is their passion for sugar and wonderful faculty of discovering it, that the smallest particle of a substance containing it is quickly covered with them."

The saccharine principle may be said to be universal in the plant world, and it is only a matter of facility of production, or quantity of yield, that decides from which of many plants our wants may be supplied. Even should the sugar cane or the beet root be lost to mankind, the palm tree or the carrot might be brought to supply our wants. With cane competition at its highest, manufactories are at work for the supply of sugar from the stalks of the sorghum and Indian corn; while Canada supplies herself largely from the sugar of the sycamore.

When a plant germinates it acts by converting starch into sugar, and this again may be converted into spirit, so that we may consider the spirits consumed in this country to represent so much sugar power, extracted from farinaceous substances. This, roughly calculated, would exceed 50,000 tons. Thus sugar planters must remember, that although they have the most saccharine of plants to operate upon, it is important to exercise the utmost economy in its production, and spare no pains to prevent waste, as otherwise organization, science, and economy, may leave them behind in the race.

But it is not our purpose at present to enter upon a discussion of important competitors to the sugar cane, in the supply of the markets of the world, but rather to occupy pleasantly a planter's play-hour.

We started with an allusion to the ants, let us return to them as there is much of interest to be gleaned from these most extraordinary insects. Dr. Davy informs us that in the case of ants being allowed access to common muscovado sugar, they would in a short time convert it into white crystalline sugar, by the removal of all impurities! He deduces from this that they find more nourishment in those portions, and suggests that its nourishing power is greatly withdrawn from it by refining—adducing the fact of the negroes preferring brown sugar to white as being "sweeter." This opens up the extensive question as to the nourishing power of sugar, while at the same time it partly answers it. Experimenters in this country generally arrive at the conclusion that sugar alone will not support life, and no doubt pure crystalline sugar, divested of all the azote originally present in it, is not sufficient to support life, any more than a diet of starch—its equivalent. On the other hand, we have important evidence to the fact that crude sugar *is* sufficient, not only to support life, but to do so in exceptional vigour. During the cane harvest the negroes, according to varied evidence, become particularly plump and sleek by living almost entirely on the raw cane, which readily ferments, showing the presence of the necessary albumen for alimentation.

One authority remarks, from personal experience, that the cane juice appeases satisfactorily both hunger and thirst. Pim found in Central America that the cane "barked," and the inside cut into handy pieces, might be eaten in quantities on a hot day advantageously. In Polynesia a native will travel for a whole day and desire no other commissariat than a piece of cane. Among the Kurds a liquor composed of hot water and sugar, flavoured with ginger and spice, enables them to break the severe fasts of the of the Ramazan. In Australia a sweet secretion of a species of *Psylla* is described as very nutritive, the natives *subsisting upon it*, and becoming fat during the season in which it is found. All these facts point to the conclusion that sugar, in the form in which it is usually found in nature, containing a proportion of mucilage or azotized matter, is peculiarly fitted for the nourishment of man; and no doubt also explains the preference of negroes and children for "brown" sugar, as an instinct of nature containing a deeper truth than the hasty conclusions of experimenters. The well-fed multitude who desire purity and sweetening power, can take the necessary azote in their roast beef.

It is questionable whether man, as an animal supplying the waste of his organisms, differs materially from many of the animals around him. We have the highly nervous ant varying its farinaceous diet with an occasional dish of sweets, or even living wholly on the latter when exceptionally plentiful. We have the frugiverous parrot tribe thronging to the *eucalypti* and subsisting entirely for lengthened periods on the stores of honey in their flowers. From these flowers also vast numbers of opossum draw their entire subsistence for a time, giving young birds and larvae a respite; while myriads of insects thrive upon them. Thus we see that nature has not in vain secreted this principle in plants; now and again displaying it openly, to give creation a taste therefor, and tempt living creatures to follow it into its deeper recesses.

In various parts of the world a sweet exudation from various trees is carefully gathered for its saccharine value, and has been named manna. In the south of Europe this is derived from the *Ornus Europæa*. In Persia and Bokhara the camel thorn *Athagi Maurorum* produces it abundantly, and it is used as a substitute for sugar; while in Syria it is produced from a species of *Tamariste*. In Australia the manna produced from the *eucalyptus viminalis* was found by Dr. T. Thomson and Professor Johnstone to differ from European manna although somewhat resembling it. It is isomeric with grape-sugar, but differs in most of its properties. The secretion of this manna commences about December and continues until March, and is so abundant in the vicinity of Melbourne that the *Yarra-yarra* is named from it.

Besides these natural exudations from plants we have those produced or secreted by insects of different species on many different classes of plants.

Thus in Turkey and Syria the larva of a species of beetle *(Larinus subrugosus cheor)* forms its nest on the twigs of a species of *Echinops*. It is composed of saccharine matter procured from the tree, and is in the form of oval cases, half to three-quarters of an inch in length, containing gum, starch, and sugar. They are collected and employed as food, under the name of trehala. *Shukur-al-ashur* is another kind, also produced by a little beetle, on a species of *Calotropis*, called mudar or ashur, in India. Dr. Livingstone mentions that in Africa a winged insect—a species of *Psylla*—covers the mopomé-tree (bauhinia) with a sweet gummy secretion, which the people collect in great quantities and use as food. Andersson also describes a tree in his journey to the Okavango River, named *omutali*, the under surface of the leaves of which bear innumerable little insect cells of a sweet sugary substance, collected in great quantities as an article of food by the natives.

In Australia likewise, we have a manna, differing entirely from that exuded from the *Eucalyptus* before mentioned, which possesses when dried a regular crystallised structure. This, called lerp by the natives, is found principally on the *Eucalyptus dumosa* or mallee-tree, in the form of little conical cups covered with white hairs. It is secreted, like that in Africa, by a species of *Psylla*. Dr. Bennett observes "although the taste of lerp is saccharine the sweetness appears to be confined to the hairs, the cup, separated, being only slightly mucilaginous."

Besides these insect productions there are many other means of satisfying the "sugar fever," without forgetting that most important and world renowned insect-production, honey. The quantity of wholesome saccharine matter gathered by this industrious creature, and made use of by man, must be very great indeed, forming as it does a most important element in the diet of many widely separated, savage or semi-civilized races. Perhaps no description of the dangers freely undergone to relieve a "sweet tooth" can out-do that by Wallace, of the Dyak honey-hunters, slowly ascending the giddy heights of the forest trees, only protected by the smoke of a torch, and cutting down the combs despite their myriad defenders. Doubtless the sweet tooth of mankind is greatly satisfied from the labours of the insect world, as above glanced at.

In the midst of our present riches, with sugar at a most modest price, we are apt to forget the humbler sources of possible supply. Yet even the lowly tribe of ferns contributes its quota. In Newfoundland the maiden's hair (*Adiantum pedatum*), a little trailing fern, and one of the most beautiful, bears a little white fruit like an ant's egg. It contains so much saccharine matter as to be lusciously sweet when made into a jam or preserve.

## CENTRAL FACTORIES.

There is a movement in favor of central factories which is extending in various sugar colonies, we noticed last month the proposal to establish a factory in St. Lucia, with a Government guarantee, and whilst we think that the Colonial Office will hesitate before it sanctions such a guarantee, we should be glad to hear that means are forthcoming to establish a factory on simple commercial principles. If the payment for the canes is not to exceed 5 per cent. of their weight in Muscovado, the margin for profit should be ample. Should the promoters decide to discard the triple effect, which is an apparatus only specially applicable to beetroot, they may afford to be much more liberal. We have before us the prospectus of a small central factory proposed to be erected in Antigua, and we are informed that a considerable proportion of the capital was at once subscribed in the island, and that a measure has passed the Legislative Council which was needed to permit the formation of the company.

We quote the following from the prospectus :—

" This company has been formed for the purpose of establishing and working in the neighbourhood of St. John's a central factory for the manufacture of concrete. It has been found by experiments made on a large scale that 10 to 11 per cent. of concrete is obtained from efficient machinery, such as it is proposed to erect at the factory, whereas, owing to the inefficient condition of the works on the neighbouring estates, barely 6 per cent. is obtained by the present manufacture.

The object therefore of the present company is to erect a steam plant and Concretor to introduce an improved system of manufacture, so as to profit by the large excess which is now lost to the planters and to the colony. It is proposed in the first instance to erect a steam plant on lands adjoining Briggins' estate, capable of making 500 tons of concrete in the season, and as opportunities offer to erect similar factories in other parts of the island.

Careful estimates have been made by the engineer, according to which the outlay for the establishment of the factory will be as follows :—

| | |
|---|---|
| For machinery .. .. .. .. .. | £3,500 |
| For building and cost of erection .... | 1,500 |
| | £5,000 |

leaving £1000 available for working capital.

Provisional contracts have already been entered into with the proprietors of estates situated in the neighbourhood of the proposed site of the factory, for the supply for a period of seven years of canes sufficient to make 400 tons of concrete per annum, and the terms of these contracts provide that the planter is to receive from the company six pounds of concrete, or its equivalent in money, for every 100 pounds of canes, and after setting aside a reserve and depreciation fund, and paying interest at the rate of 15 per cent. per annum to the shareholders in the company, one half of the surplus profits is to go to the shareholders and the other half to be divided rateably among the contractors supplying canes. The engineer's estimates show, on the basis of these contracts, a return of at least 25 per cent. per annum to the shareholders.

The success which appears to have attended the small concrete central factories in Guadaloupe has led to the proposed establishment of others.

The magnificent factory erected in Trinidad by the Colonial Company has been in operation, and will be ready for full work for the ensuing crop.

The following particulars we extract from the *Universal de Santo Domingo:*—

Trinidad, July 26, 1873.

The great central sugar factory recently established in Trinidad, at Pettymorne, is a stupendous wonder; vast in dimensions, extraordinary in the variety of its processes, perfect in result, as proved within these few weeks by the beautiful sugar made from molasses—everything that can be done automatically, at least by steam or gravity, performed without human labour, with a present power of making 30 hhds. of white sugar a day, or 3,000 in a season of 100 grinding days, or double the amount whenever the company choose to add the duplicate set of primary vessels and a crushing engine, for which accommodation is prepared. The works are about 4½ miles out of San Fernando, reached by an excellent road, and are within easy distance of the Cipero Tramway. The great mill is iron-framed, filled in with brick; it is 325 ft. long, 115 ft.

wide, 48 ft. high to centre of roof. It has three brick chimneys of 133, 100, and 60 feet high respectively. It has a monster water reservoir which covers 13 acres, 23 ft. deep in centre; and a smaller one covering 9 acres, presenting a depth of 33 ft. Seven conjoined estates will supply the canes by railway—eight or nine miles of which are laid down—worked by locomotives running up every vale and hollow where suitable grades can be found; in addition to these the Colonial Company has leased the Golconda, two miles off, equal to 700 or 800 hhds. of 40-in. truss, and is extending its line of rail to it. The quantity of cane laid down on all these estates is much more than the mill is likely to work till the duplicate set of grinding machinery, vacuum pans, and a second *triple effet* apparatus are erected, with an addition to the number of clarifiers, subsiders, filters, and centrifugals. The greater the quantity of produce the less the expense on the cwt. in sugar, and per gallon in rum. The beauty of the sugar made out of dirty common molasses is surprising; it sells readily at 8c. per lb. The next crop will settle beyond cavil the success of the undertaking, which is very flattering now, considering what it works out of common molasses, and much more satisfactory wil it be when the juice direct from the cane is used in manufacturing.

The emancipation of the slaves in Porto Rico is coupled with an indemnification to their former masters of 7,000,000 of dollars, which is to be obtained by a loan to be repaid by a tax upon the island for this purpose. It is not easy to see how this process in itself can be a very profitable one; it is, however, proposed to expend the money in the establishment of a number of central factories, and the Porto Rico newspapers are filled with articles and calculations on the subject. Some writers advocate the use of a triple effect, whilst others appear to have their attention turned to the advantages supposed to attach to the use of the Concretor. The money, however, will need to be borrowed somewhere, but whether in England or in France appears not to have been decided. A guarantee by the Spanish Government would not be favorably received in this country, but a loan secured by the factories and guaranteed by the island would be safer than many a security that is readily taken up.

## ON BEET-ROOT AND BEET-ROOT SUGAR.

(*From a Pamphlet by E. F. Cull, of The Canada Company, Toronto.*)

### INTRODUCTORY.

"Beet root sugar! Ah yes, we all know they make a great deal of it on the Continent of Europe, more particularly in France and Germany, but as no manufactory of it can be conducted except on an enormous scale, and with a heavy outlay of capital, it will not suit Canada where labour is so high, and the climate is unfitted for it."

This is the observation which the writer has had to combat in speaking of the subject with every tolerably well-informed person, while to those who knew nothing about it, the matter seemed to be enveloped in such a hopeless mystery that few could be got to approach it. After exhausting every other objection the cavilier would say: "You do not understand the subject yourself; you have never made beet root sugar; book learning wont answer in a case of this kind;" and so on.

To meet these objections there was but one course, namely, to go at once into the practical manufacture of the article on a small working scale; to learn the whole business, and be able to reply to objections; my knowledge is derived not from books alone, but from practice as well. I make such an article of crude sugar that it is saleable to the refinery, in the following manner; obey my instructions and you may make it too.

As, however, it is important to carry the reader fully with me, I shall show how it was that beet root sugar first came to be used, and why it has been considered a *sine qua non* that it should be made on a large scale.

Beet root sugar, as a national production and grand article of domestic use and manufacture, originated with the great Emperor Napoleon. His continental system, and the enormous wars attendant thereupon, cut France off from communication with the tropical climates where the sugar of the world had at that time been produced, and thus deprived the nation of a grand necessity, as well as a grand luxury (for it is now considered by all that not only is sugar a luxury but a necessity in the broadest sense of the term), and Napoleon well understood that, although, a nation under certain circumstances will submit to be debarred from civil and political rights, yet touch the human family in any matter of daily use or daily indulgence, and they become ungovernable.

Under these circumstances he called the great chemists of France together and said, France requires sugar, the tropics are closed to us, our supply of sugar is cut off. It must be had as an article of French production and home industry; the nation requires it: the resources of the empire are at your command; but sugar must be had at any cost; make it.

The entire chemical talent of France was, therefore, turned to this point. At first they made a chemical sweet which was called sugar, but it was not sugar, and did not meet the public requirements. Then they turned their attention to the beet root, and they found that this root would yield the required substance.

But chemists as a body are governed by entirely different rules from mercantile manufacturers; chemists look chiefly to the success in their processes without counting cost; to the mercantile manufacturer everything else must bend to cost, his ultimate end is profit.

The French chemists not only had to supply sugar, but to supply it on an enormous scale, and the works were erected of a corresponding magnitude—the works were not calculated for *profit* but for *supply*—and as the manufacturers could in the first place demand their own price (as sugar, in France, could be obtained nowhere else) the works were *made*, in some measure, remunerative as well as to afford the public what was wanted.

After the continental war was closed, and the French were again able to enter the markets of the world, and get sugar as cheaply as any one else, the first real struggle of the beet sugar manufacturers commenced. They had to work against slave labour and against cane sugar, and also against the accumulations of stock and production and preparation for growth which had taken place while the continental markets were closed; and then for the first time it became a fair race between beet sugar and cane sugar. About that time also the beet sugar people got a great advantage over their opponents of the tropics by the abolition of slavery in the principal sugar producing countries, and it was then (with the exception of Cuba, Brazil, and the United States) free labour in the tropics with the sugar cane against free labour with the beet in Europe; and the beet sugar has ever since gallantly held its own against all opposition.

It was during this struggle that the enormous factories of beet sugar did good service to the cause; they had so much capital locked up in them that further expense to keep their position became a matter of necessity, and no cost was spared to produce efficiency, and it was then that the great improvements in the manufacture were made.

The processes were, however, kept as secret as possible, and the public was carefully indoctrinated with the idea that beet sugar could not be profitably made except in the enormous factories on the continent.

Modern science and enquiry, and the easy communication of nation with nation of the present day have gone far to open up the close corporation of the beet sugar manufacturers, and it will be seen by the following record that the mysteries so long shrouding the process, have been swept away, and the full particulars are now offered to the world at large.

The writer claims nothing absolutely new in the process set forth: the arrangement of the various processes is new; but more so by the suppression of superfluities than by additions. The new part of the process is the fact that by following the instructions hereafter given, twenty-five pounds of beet root may be manufactured into a merchantable sweet, in domestic utensils as readily as two hundred and fifty tons of beet root are ordinarily reduced in one of the monster factories of the European continent.

### THE MANUFACTURE OF BEET ROOT SUGAR.

The most important thing the person can do who is to enter upon this manufacture is to forget all and every thing he has ever known about sugar making, particularly that which is made from the maple; and he must especially bear this maxim in mind, viz.:—

Beet root sugar is not, never has been, and, the writer believes, never can be, made into an article of domestic use, until it has been refined by a separate process.

It is an article which is made by the producer to sell to the refiner, and not to use as it is made by the first manufacturer. The crude article is quite equal in value, according to the sugar it contains, to the best brown cane sugar, commonly called muscovado, and far superior (when well made) to the lower grades of sugars, (those with a fine soft grain), which come from tropical climates.

All sugars, except maple sugar, are made at two processes—in the first the juice, whether from the sugar cane or from the beet, is defecated and boiled down to the crystallizing point; it is then set by in cisterns until the crystals have formed, when it is shovelled into barrels, and the molasses is made to drip from the sugar. The sugar is then shipped to England and America and elsewhere, and refined into loaf and into the finer kinds of soft sugar in the great refineries.

In France and Germany all the great manufacturers produce the sugar first as crude sugar, and then refine it; they are now, however, in many instances working the branches separately.

*(To be continued.)*

## MEMORIAL OF THE BRITISH SUGAR REFINERS' COMMITTEE.

"*To the Right Honourable W. E. Gladstone, First Lord of H.M. Treasury and Chancellor of H.M. Exchequer.*

"Sir,—The Paris *Journal des Fabricants de Sucre* of August 7 publishes a letter, addressed on June 30 by the Minister of Commerce to the reporter of the sugar commission, in which it is stated that, owing to the refusal of Her Majesty's Government to adhere to the protocol adopted at the recent conference in Paris, and also owing to the attitude of the Belgium sugar manufacturers, who have protested against any increase in the legal yield, and have pronounced in favour of the existing state of things, or for refining in bond, the Minister of Commerce thinks it desirable to invite a fresh meeting of the conference, to be held in Brussels towards the end of August or beginning of September. This being the case, we take the liberty of again addressing you in order to urge—

"1. That France, if it invites another conference, is now bound loyally to support refining in bond, and that therefore representations to that effect may be made to it prior to the meeting of the conference.

"2. That, from evidence which we now possess, Belguim cannot continue to defend either its present system, or the modification before suggested, and therefore representations to that effect be made to it prior to the meeting of the conference.

"3. That if this third conference is also without result, our representatives may be instructed, prior to the closing of the conference, to insist on the immediate cessation of two flagrant breaches of the terms of the convention, viz. :—(1.) The détaxe on white crystals in France, by which the French refiners are permitted to receive pure white sugar (of which 110,000 tons are produced annually in the French beetroot factories), at a duty of 3 frs. below that which it ought to pay, according to the terms of the convention; and—(2.) The colour standard representing the upper limit of the third class, which, for beetroot sugar, is now two or three Dutch numbers above the point fixed by the convention, thus largely increasing the quantity of that class of sugar in France, which, though assessed as yielding only 80 per cent. of refined, habitually yields 85 to 87, and frequently 90 per cent.

"1. Our grounds for urging that the French Government, if it invites another conference, is bound loyally to support the proposal for the international adoption of refining in bond. and for praying that representations to that effect may be made to it, are, that its superior council of commerce has reported in favour of that system, that the Commission of the National Assembly has twice reported that refining in bond is the only remedy for the present evils, that the arguments brought forward in the National Assembly have all tended in the same direction, and now, finally, that while two conferences have resulted in the failure of all alternative propositions, many official admissions on the part of the French Government have been made, that the present state of things is in every way opposed to the object for which the convention was entered into. As one, and perhaps the most definite, of these admissions, we refer you to the words of the late Minister of Commerce, quoted by us in our memorial of March 3. (*Sugar Duties, Memorials from the Trade*, March, 1873, page 74.)

"2. The evidence which we can now bring forward to prove that the Belgian Government, by its own showing, cannot any longer uphold the present system, is contained in a Belgian newspaper entitled *La Sucrerie Belge*, in which, at page 279 of No. 20, for June 2, 1873, will be found a reprint of the Exposé des motifs du projet de loi déposé a la Séance de la Chambre des Représentants, du Novembre 28, 1871, per M. Jacobs, Ministre des Finances." This document is sufficient proof and admission that the present system in Belgium is distinctly opposed to the object of the convention. The document which follows at page 285 of the same paper, "Note sur le projet de loi sur les Sucres," is good evidence that, at all events in the opinion of the Belgian sugar manufacturers, the remedy proposed in the *projet de loi* of 1871, and offered by the Belgian representatives at the two recent conferences, would prove to be no remedy.

"3. It is quite possible that the conference about to be held may result like those which have recently taken place, and we hope and respectfully request that in that case our representatives will take such steps as may procure an immediate return to the strict terms of the convention with regard to the two points to which we have alluded, and which have already been brought before your notice in our former memorials (*Sugar Duties, Memorials of the Trade*, pages 21, 51, 55, 56, 57 to 64). Even for the short time during which the present convention will last (till August 1875) it is of the utmost importance to our trade, in view of the rapid increase in the export of foreign refined sugar from France under the present heavy bounties, that justice should be done us in these two respects, which at present materially assist in aggravating the protection accorded to the French refiners.

"In conclusion, we take the liberty of respectfully asking what position will be given to our trade by her Majesty's Government, as regards free trade with France and other countries, in the event of the termination of the present convention, either from a lapse of time or from an abolition of the sugar duties in this country? We respectfully submit that in our opinion our trade, which has suffered so much from a protected foreign competition, will, when the present convention ceases, have as strong, if not a stronger claim to such treaty stipulations as may secure to it freedom of trade on both sides of the Channel, as any of those trades which are now included in the recently renewed Treaty of 1860. We humbly pray, therefore, in conclusion, her Majesty's Government will take this contingency into their serious consideration, and will make such representations to the Powers interested in the present convention as may procure for our trade, in the event of a sudden termination on our part of the present convention through the abolition of our sugar duties, such security by treaty stipulations as it has a right, in common with the other trades included in the Treaty of 1860, to expect."

*London, August 29th,* 1873.

## *Note upon the "projet de loi" on Sugars, presented 28th November,* 1871.

We agree with the Government on two points: 1st, that considerable quantities of sugar enter into consumption free from duty; 2nd, that it is to this circumstance that Belgium owes, in part at least, the considerable development of sugar manufacture in the last six years, a development such that it must fatally lead to a crisis unless we hasten to bear a remedy to the evil.

We differ from the Government regarding the means. We think, 1st, that Government is mistaken when it sees in the legal yield of

1,500 gr. of sugar per hectolitre of juice, and by degree of density, the only or at least the principal cause of the surpluses of manufacture; 2nd, that the increase of yield proposed by Government, and above all the system of progressive yield which the *projet de loi* introduces, would have as a consequence, if not to diminish at least not to increase the Treasury receipts, and to fail in the double and very praiseworthy end which it proposes, that is to say, to increase the receipt of the fiscal duty on sugars, and to guarantee against a fatal crisis an industry which furnishes considerable nourishment to a great number of other Belgian industries and constitutes a very important source of prosperity for the principal industry of the country—Agriculture.

These are the two points which we will try to establish.

For the case in which Government would not defer to the unanimous wish of the Belgian sugar manufacturers, which is the abolition of the duties on sugar, as on salt, we must come to the conclusion that the actual law is not so bad as one seems to think, but that it is badly carried into effect; that it is important then to maintain it until, by common agreement of the co-signers of the convention of 1864, this convention shall give place to a new mode of levying the fiscal duty in the four countries; that in the mean time the Belgian Government should come to an understanding with that of Holland (where the Belgian system of abonnement is equally in use), with the view of taking, mutually, measures for assuring the Treasury of the two countries the real collection of the fiscal duty on the legal yield.

The Belgian Government, in the *exposé des motifs*, repudiates the system of the inspection on account of the frauds to which it gave rise in 1845, when it was tried in Belgium. Perhaps at this time the inspection system was not surrounded by those guarantees which to-day in France assures the return of the impost infinitely better than in Belgium and in Holland.

The inspection system in France takes notice of the whole amount of sugar which proceeds from a manufactory. No amount can be taken from a manufactory without a previous declaration, and the document which should accompany the merchandize even to its destination allows throughout all its passage the discovery of fraud, if it were tried to be committed. Still further, the weight of sugar sent out from the centrifugal machine is determined by permanent employees, and the statement can easily be made to discover possible frauds. In the system of subscription, on the contrary, all the guarantee of the Treasury rests on the fidelity of the employees charged with the permanent surveillance. But, on the one side, these employees, badly paid, are recruited in a greater part from amongst temporary people, who have no knowledge and little hope of advancement; on the other part, fraud can be committed either in diminishing the density of the juice tested, or in allowing the juice to go into the manufactory without charge: no trace remains. The most active watchfulness of the superior officers, the arrival of whom is known a few minutes in advance, can do nothing against the frauds in which permanent employees are accomplices.

It cannot be denied that the system of abonnement renders fraud easy; they can under this *régime* practice them on a grand scale, and are almost assured of impunity. It is not so under the *régime* of inspection: the danger is greater and the quantities to defraud necessarily less.

That is a secret of the preference given in Holland to the system of abonnement. One could not understand, without that, the fabulous bounties distributed by the greater number of Dutch manufactories, notwithstanding the price of beetroot unknown elsewhere. The competition among the manufacturers in Holland to obtain beetroots has raised the price to 13 florins, being beyond 27·50 francs per 1000 kilos., price at the places of production, and to this price must be added at least 5 francs for commission, transport, reception, and cartage. Thus the raw material costs 32·50 francs. *It is not in France that they work with beetroots at this price.*

But we have another motive for thinking that the preference given by Holland to the system of abonnement does not come from the surpluses which they there legitimately obtain over the legal *prise en charge*. This motive is found in that which passes under the same *régime* in Belgium. It is from the latter evidence that in our country considerable quantities of juice are secured from the *prise en charge*, thanks to the facilities accorded by the abonnement. For ten years, in reality, the official consumption of sugar has remained stationary in Belgium, whilst it has progressed in equal proportion even in France. It has remained stationary at 16 millions of kilos., notwithstanding: 1st. the increase of the population and the general well being; 2nd. the increase of the *prise en charge*, in 1865, from 1400 grammes to 1500 grammes; 3rd. the diminution of the *decharge* allowed to the exit of refined and the suppression of the drawback on syrups. If one takes these elements into account and reflects on the increase of the consumption in Germany which has been during the last ten years from 37 per cent., one must legitimately conclude that the real consumption of sugar in Belgium has become double since 1860. Who then has absorbed these 16 millions of kilos. of which the Treasury sees nothing.

The *exposé des motifs* replies that these are the legitimate excesses upon the legal assessment of 1500 grammes. Here lies the mistake, as can be proved by a simple calculation.

In 1860 the total assessment amounted to 17 million kilogrammes; in 1870 it was 48 millions. We have thus a difference of 34 millions, out of which arises, according to the *exposé des motifs*, such surplus as has been able to absorb the increase in the consumption, that is to say, 16 million kilogrammes. Whatever exaggerated idea may be entertained regarding excesses, it is evident that they have not absorbed this amount. Let us admit that by some impossibility the amount of excesses amounts to 15 per cent., which would cause the real yield to attain an average of 1725 grammes; the increase of manufacture and exportation having been 31 millions there would only be sent into consumption free of duty 4,700,000 kilos. If instead of estimating the legitimate excesses at 45 per cent. we take as a basis for calculation the excesses stated by Government within the manufactories situated in Belgium in the Custom-house radius *we obtain a surplus of* 9 *per cent., that is to say* 2,800,000 *kilogrammes.*

It is then evident that the Government is mistaken. And let us remark that this error might be extremely grievous in its results.

It would have in reality as consequences to exaggerate the amount of assessment, of failing to arrest the factitious prosperity of the industry of hastening the crises, of rendering it more intense, and lastly of compelling honest manufacturers to have recourse in their turn to underhand practices, as a means of sustaining a competition which would not, except for the exigencies of the Treasury, and the facilities afforded by them for fraud.

There is brought forward in the second place as an objection, the facts possessed by Government, regarding a certain number of manufactories situated within the Custom-house district, and when the excesses have been 9 per cent, the yield being 1632 grammes.

This objection partly destroys the preceding one, and confirms what we have said regarding the motive which gives the preference to the abonnement in Holland. If in reality the average of the last five years, has given in the manufactories situated in Belgium, within the Custom-house district, only a yield of 1632 grammes; how can it be supposed that the yield in Holland exceeds 1635 grammes, and that in such a proportion that the manufacturer sees in the probable surplus a sufficient compensation for the eventual deficit.

We have already observed that if this figure of 1632 grs. should be accepted as an average legal production the result will be that the quantity of sugar duly free from duty on consumption, it could not be increased in ten years more than 2,800,000 and that would not explain the cause of the remaining of the deficit which is increased to nearly 16 millions.

In short, the production being in opposition with the results stated in France it must be admitted that the sugars from these manufactories were under the amount of 88 per cent. of saccharine richness.

We must then conclude that the Government is mistaken when it attributes the situation to the surpluses *legitimately* made over the legal *prise en charge* of 1500 gr.; that there is consequently no need to increase it; that the only measure to take at this time is to join with Holland so as to render fraud in the manufactories impossible, each one seeking a means of collecting the fiscal duties on sugar in the four countries bound by the convention of 1864, in a manner favouring no one and assuring to the Treasuries of the four countries the collection of the duty in its entirety.

Let us again observe: on the one side that fraud, by the statement of false densities, leaves no trace, and consequently is sure of impunity; and on the other side, that it does not require the intervention of a workman, and consequently cannot be denounced. It is possible, then, to do it in the easiest manner, and it astonishes us that the treasury, which has so little confidence in the taxpayers, should have bound themselves to such a method.

*La Sucrerie Indigene* (a review which appears in France) contains in its number of Feb. 5th, two articles which approve of the Belgian *projet de loi.* In making our reservations on certain of these approvals, particularly on this which concerns the good faith of our Government, we think to show these two facts:—1. That in France we attribute the Belgian excesses not to the assessment of the legal produce but to fraud; 2, that in France we consider that the *projet de loi*, if it is accepted, will increase still further these surpluses, and that the system of progressive yield will contribute in a large degree to this result.

We adhere to the conclusion of the two articles in the *Sucrerie Indigene*, namely, that the solution of the question remains in the discovery, by a common accord among the others signing the Convention of 1864, of a proper method of ascertaining the real produce of the manufacture in such a manner as to make the impost on sugar to be paid on the total quantity produced.

We cannot praise any system other than the total suppression of the duty. It is sufficient for us to state, that before all things we wish to make the sugar industry, an industry earnest, honest, and stable.

Whatever may be the course decided upon, we ask that we should be heard, when the question at stake shall be to modify a legislation which exerts such an influence on the prosperity of our industry; not for the purpose of imposing our opinions, but to enlighten those who rule its destiny.

We would willingly admit that our claims are not exaggerated, and that the instability of our sugar legislation justifies the demand which tends to a deeper inquiry and to a cross-examination.

## *Note on the Projet de loi, from "La Sucrerie Belge," of August 21st, 1873.*

At the meeting of August 13th, the Council of Administration of the Society General of the Belgian Sugar Manufacturers has decided to send the following letter to the Minister of Finance:—

"Sir,

"In the number of the "*Journal des Fabricants de Sucre de France*," for August 7th, we read as follows:—

"The following is the letter dated 30th June, of the Minister of Commerce and Agriculture, sent to M. Villain, reporter of the Sugar Commission:—

"M. the Minister of Foreign Affairs, informs me that the government of Her Britannic Majesty has refused to adhere to the protocol resolved upon by the international conference which is assembled at Paris. On the other side, M. the Duke de Broglie informs me that the assembly of the Belgian sugar manufacturers protests against the increase of the legal yield, and pronounces for the maintenance of things in "*statu quo*," or if not, for the system of taxation on consumption with inspection of the refineries.

"In this situation, in presence of the refusal of England, and the attitude of the *Sucrerie Belge*, and under the idea that these new circumstances might modify the dispositions of the powers signing the Convention of Nov. 8th, 1864, I have thought that it would be expedient to assemble a new international conference which would be held at Brussels towards the end of August or the beginning of September next.

"As the resolution to intervene would necessarily have some action upon the "*projet de loi*" at this moment under the deliberations of the assembly, I come to ask you to be good enough to propose to the commission to adjourn the second reading till after the close of the conference. It is not thought that any grave inconvenience will result to the interests of those engaged in the question by this delay.

"Receive, &c."

On the eve of seeing a new conference opened which should be occupied with the sugar question, and which will probably decide the fate of our industry, we, the undersigned, sugar manufacturers, and members of the Committee of the sugar manufacturers of Belgium think it our duty to express anew our opinion on this matter.

We demand no privilege. We demand an equitable and uniform legislation in the four countries bound by the Convention of 1864, a legislation henceforth under shelter from the continual variation which causes disturbance to respectable interests, a legislation based upon a respect for industrial rights, the guarantee of the public treasuries, and the assured repression of fraud.

From this threefold point of view the system of types, as the basis of the collection of the sugar duty, is decidedly condemned.

We are in this statement in perfect agreement with the honorable officers whom you deputed to represent Belgium at the last conference in Paris.

Monsieur Fisco, in a long memoir, read at the meeting of April 19th, 1873, expressed himself thus:—

"A double conclusion is arrived at from these facts: the first is, that the average yield from raw sugars, fixed in consequence of the experiments at Cologne is erroneous, and the second that *the colour of sugars is a false index of their richness.*

"The refiner can always make himself certain of a bounty by only employing those from the numbers of each class of which the real exceeds the legal yield.

"Sugars factitiously colored can be produced, which, according to their color belong to the third or fourth class, whilst, according to their real richness, should be placed in the second class."

We regret to say that on nearly all the other points brought forward by the honorable representative of Belgium at the Paris conference, we look at them from a different point of view from him.

In the first place M. Fisco affirms that "the *prise en charge* in Belgium and in the Netherlands is not sufficiently high."

We have often had occasion to observe that the 1500 grammes per hectolitre of juice and degree of density represent sugar titrating 88°, and that it is not possible to obtain this as an average yield, without recurrence to fraud.

We have adduced, in support of this assertion, the real yields obtained in France from 1860-61 to 1869-70, communicated by the then Minister of Finance to the central section charged with the examination of the *projet de loi* on the free entry of foods, brought forward in 1871. During this decade the average yield was of $1531\frac{7}{10}$ grammes, not on sugar at 88°, but *on sugars of all colors and all qualities*.

We have said that in Holland, when the yield is 1635 grammes, surpluses are still obtained; and that in Belgium, where in 1865 and 1866 the *prise en charge* was raised from 1400 to 1500 grammes, the Treasury receipt has not increased.

We persist in thinking that the surpluses come not so much from the rate of the *prise en charge* as from the bad method adopted for the collection of the duty.

The remedy does not lie then in the increase of the *prise en charge*, but in the suppression of the *abonnement* system.

M. Fisco rejects the inspection system. He gives various reasons for it, we will examine them curtly.

1. "The inspection-system is irreconcileable with the economic *régimé* of Belgium, which has for its basis liberty of work, transacting interchanges, and carriage."

But, if it is a system contrary to liberty of transacting business, it is to that of *abonnement* as well. We are in reality not permitted to introduce a new system of work, an apparatus recently invented, nor to make the smallest experiment without previous permission. This permission is often refused on the pretext that the method of inspection is not applicable to it; at another time it is subordinated to measures which render its use impossible. We will mention pulp-sieves, diffusion, continual presses, &c., &c.

As to freedom of barter, and carriage, the inspection-system would bear no impediment. It is sufficient that the works be under surveillance, that the keys of the sugar magazine be in the hands of the employés, that the control of the amounts of sugar in the magazine be possible.

The difficulties raised are pretexts, for it is incomprehensible that the employés charged to ascertain the amounts of sugar be mistrusted, when they are trusted to ascertain the quantity of juice.

2. "The inspection of the refineries is impossible." But it will be sufficient for us to point out this which is in practice in France, where the refinery-manufactories are under inspection without having marked abuses.

The operations of the refinery are not more difficult to follow than those of sugar manufacture. On the one part they work on beetroots from which they press the juice, on the other hand they work on sugars reduced to syrups by melting. From this time the two sugar liquids undergo the same operations: refining, filtration, evaporation, drying, crystallization, passing through the centrifugal, or drainage. There is nothing evident there which might hinder in a refinery the inspection which is possible in a sugar works.

3. "An inventory is not possible in a refinery." The complaisance with which certain refiners are believed in this matter on trust is worthy of admiration. This inventory is perfectly possible, since it is done every year in all the works and particularly in the refinery-manufactories of France. Wherefore can it not be required that the refiner give proof each year of the existence in refined products or syrups of the weight of raw sugar sent into his works, under a deduction of 2 or 3 per cent. for loss.

But this inventory is not indispensable for the guarantee of the Treasury. From the time the sugars bought (loaf or moist) are ascertained on their entrance to the magazine, it is only very small quantities they are able to screen from duty.

It is not in the condition of syrup that sugar will be carried away, and when it is crystallized it is under the control of the Government officers. These officers, it is said, are frail and corruptible. But what then are those who have the supervision of beet-root factories?

4. "The consumption of sugar in Belgium is too limited for it to be possible to organize a system of surveillance which would

entail expenses so heavy as those necessary for working under inspection." We believe that working under inspection, the revenue would not be long in increasing, and that this augmentation would much exceed the sum which surveillance under the Excise would cost; though the argument tells less against refining under inspection than against the sugar duty itself. We think that in Belgium, where sugar only yields 6 to 7 millions of francs, it would be better to abolish the duty altogether, and thus escape from all the difficulties of collecting it. Belgium does not, like France, derive a sufficiently considerable revenue from sugar to make it desirable to maintain the duty in the midst of the difficulties of every kind raised by its collection.

5. "Working under inspection would not solve all the difficulties; it would be necessary to maintain the types." Sugar is only consumed in three forms, as candy, loaves, and crushed. Each of these forms should have its own duty. There ought to be no difficulty as to the two first. A uniform duty ought to be levied on all crushed sugar, raw or refined, and be payable on its entering into consumption. This would not involve the necessity of fixing a yield, as the duty would not be levied on sugar going into a refinery, but only on sugar going at once into consumption. As all wine pays the same duty, without distinction of quality or value, so it ought to be with all crushed sugars.

M. Fisco, who heaps round supervision under inspection difficulties without number, thinks that he has the solution of the problem, by combining a simplified method of optical analysis with the types and a declaration by the taxpayer of the degree of polarization.

We cannot agree with M. Fisco, and it is almost useless to reiterate the contradictions into which he falls.

After having said that "the colour of sugar is a deceptive indication of saccharine richness," he ends by maintaining the types as bases of his system! Saccharimetry is employed only as a means of verification in case of dispute.

The type is the rule and he is obliged to maintain it, because analysis, however much we can suppose it to be simplified, cannot be applied to the numerous samples of which it would be necessary to determine the richness in a short period of three months.

The proposition that the taxpayer should declare the degree of polarization of sugar offered by himself for exportation, shows that its author cannot be very familiar with commerce.

All who are engaged in selling and buying sugar know how difficult it is to determine the richness of a parcel of sugar; and that it is not uncommon to draw, from the same parcel, samples differing in results to the extent of several degrees. It is also well known that the same sample submitted to the analysis of several chemists will often be valued differently. Arising either from inexactitude, confusion of samples, error of observation, faulty apparatus, or absence of homogeneity in the sample itself, experience has demonstrated that the manufacturer cannot trust absolutely to the analyses given to him by even the best chemists. And would it be reasonable to make the manufacturer responsible for the error, or for the negligence of a chemist, and punish him on this account, nay, with a fine, perhaps even with the confiscation of the merchandize? It would be supremely unjust to do so. A man may be responsible for his own act or for his own negligence, but to make himself responsible in law for the act of another, when no fault can be imputed to him, would be to set aside the most elementary ideas of justice, and we trust that in no county would such a course find a parliament to sanction it.

It is useless to raise as an objection what the practice is in Belgium, where the manufacturer is obliged to fix the class to which the sugar he exports belongs. Taxation by colour, although difficult under many circumstances is always the act of the manufacturer himself, and in doubtful cases he can have recourse beforehand to official advice.

With reference to saccharimetry as a basis for the imposition of duty—we absolutely repudiate it, equally on account of the frauds which might arise in the taking of samples, the difficulties it would put in the way of disposing of merchandize which ought to be sold at once, the errors to which analysis necessarily gives rise, and the possible confusion of samples; but above all because saccharimetry by difference, as explained by annex B in the protocol of the closing of the Conference of Paris is purely empirical and rests upon no scientific datum. It would have been useful to have known the Belgian report to which M. Uyhtenhooven made allusion at the Meeting of the 22nd April, 1873. We are obliged, sir, to indicate very briefly the principal reasons which prevent our adherence to the propositions made in the name of Belgium at the Conference of Paris.

We think that were these propositions accepted they would give rise to inconveniences equally as grave as are those to which they are intended to put an end.

We think that the maintenance of the contract with an increase of the yield demanded beyond 1,500 grammes would only aggravate evil from which the beet sugar manufacturer suffers at present in Belgium, and precipitate a crisis which could only be averted by radical measures.

It would be a strange illusion not to see that the prosperity of the sugar industry in Belguim is more artificial than real, and that our legislation has had a large hand in its prodigious and abnormal development of late years.

We therefore pray that you will not persist with measures which cannot bring complete relief. We cannot be suspected in asking this from you, since the abolition of the duty itself for the benefit of the consumer, or the adoption of the equitable and rational system of paying the duty on the manufactured article as it passes into consumption would abolish every privilege bounty, or unfair advantage of every kind.

*Brussels*, 13*th August*, 1865.

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*The following Petition has just been addressed by the Sugar Refiners of Belgium to the Minister of Finance:—*

Antwerp, 1st August, 1873.

Sir,

The undersigned refiners of sugar have the honour to point out to you

That article 4 of the convention of the 8th November, 1864, is not carried out by France.

That no relation exists between the duties on import, and the drawback allowed on exportation, of raw sugar.

That while sugars inferior to No. 7 of which the legal yield is only 67 kilos. pay 63 fr. duty per 100 kilos.; Sugars from 15 to 18, with a yield of 94 kilos., only pay 66 fr.

That contrary to the Article of the said Convention, sugars superior to No. 19, showing generally 99 to 99½ degrees, and which pay in Belgium the duty on refined, have only imposed upon them in France 67·50 fr., when the duty on refined there is 73·27 fr.

This condition of things, contrary to the engagements contracted by France which each of the contracting powers can insist upon being carried out, *obliges* the French refiners to export *at any cost* their refined in order to enjoy the bounty, and to inundate Belgium with French refined at prices lower than those in France, and against which our similar industry, deprived of all protection, cannot much longer contend.

We address ourselves to your sense of justice and pray that you will at once insist on the French Government executing articles 1 and 4 of the Convention of 1864, by assimilating sugars superior to No. 19 to refined, and by establishing the correlation determined by article 4.

There are two circumstances which may be made to lead to a prompt termination to this negociation, viz., the exchange of ratification of the Franco-Belgian treaty and the next conference, which ought to meet at Brussels to examine the modifications to be introduced into the convention of 1864. If contrary to her *formal and incontestable engagements* France refuses to pay attention without delay to our complaints, we pray that the Government will impose on the entry of French refined sugars into Belgium a sum equal to the protection which exportation, under the existing circumstances, procures for them, and which we estimate at a minimum of 7fr. the 100 kilos.

Our demand, sir, has nothing about it which is not perfectly justifiable if fairly discussed, and we venture to hope that you will take the neccessary measures for insuring justice.

[Here follow the names of 35 Belgian refiners.]

## THE CANE BORER IN THE MAURITIUS.

(*Continued from page* 483.)

The Committee is so convinced of the necessity of a general and combined action in carrying out these measures, that they do not hesitate to suggest and recommend in the most pressing manner, that a legislative regulation be passed to render obligatory the burning of all squares of canes at latest within ten days of the canes having been cut, failing which the Police Magistrate upon information by affidavit of two known persons, shall order the said fields to be burnt at the cost and risk of the owner or occupier of the same refusing to comply with the regulations.

Such a suggestion finds its justification in itself, almost all legislations contain similar regulations, they are based upon the necessity of protecting society against such offences and misdemeanours, and are the consequence of this principle of eternal justice which renders us responsible of all wrong done to others. The mere threat will generally suffice to overcome the error or obstinacy of a small number. This error comes from the belief that the light of the fires will attract the insects from the neighbour's fields, and the obstinancy comes from an other erroneous belief that burning the straw destroys the principal substance of artificial manures, and dries up the ground. It has been shown that the incineration of these remains was more advantageous than to convert them into manure; and it is evident that, if the drought was such as to be hurtful to the cane plantations, the burning would have added but very little to the injury, even admitting that such was the case, it would be much less than the damage arising out of the ravages of the Borer.

We are not aware of other efficacious remedies than getting rid in a direct manner of the insects, poisoning, suffocation and fire, and we give a decided preference to this last which appears practical, sure and sufficient. If, however, experience should point out some other remedy more efficacious, we would be happy to recommend it, but as long as no satisfactory experiment shall have been made, we think that it would be dangerous to deceive onesself with hopes which would delay the immediate use of known remedies and increase the evil.

We must here repeat the recommendations that we have made in our preliminary report on the precautions to be observed with regard to the plantations—they consist in selecting cane plants free from any trace of the insect, to strip them of all leaves and even to wipe or wash them to get rid of the eggs that might adhere to them.

In conclusion, we recommend :—

1. To burn all the useless remains of the sugar cane, with care, perseverance, and unity of purpose.

2. To cut away, as much as possible, all young shoots already attacked.

3. To remove the straw or dead leaves from all young cane plantations—to cart away the same immediately, to be burnt with care.

4. To put into the ground only such cane plants as are free from insects—and to insure this, strip them of all their leaves.

5. To pass such legislative regulations as shall compel all planters to act with unity.

The Committee hope that, with the assistance of these simple measures, it will be possible to free our Colonial Agriculture, within a few years, from an insect which threatens it with ruin—but at the same time they think it their duty to declare that, in their opinion, this ruin is certain, if such measures, or others which experience may hereafter recommend as more efficacious, are not immediately adopted and carried out with energy.

The Committee have accomplished, as well as they have been able, the task which it has pleased Your Excellency to entrust to them.

They thank Your Excellency for the disbursements already authorized, with the view of assisting them in their investigations. They take the liberty of suggesting that this Report, if it meet with your approbation, be printed in French and in English, and distributed to all Cane Planters, and that the accompanying drawings be lithographed for the same purpose.

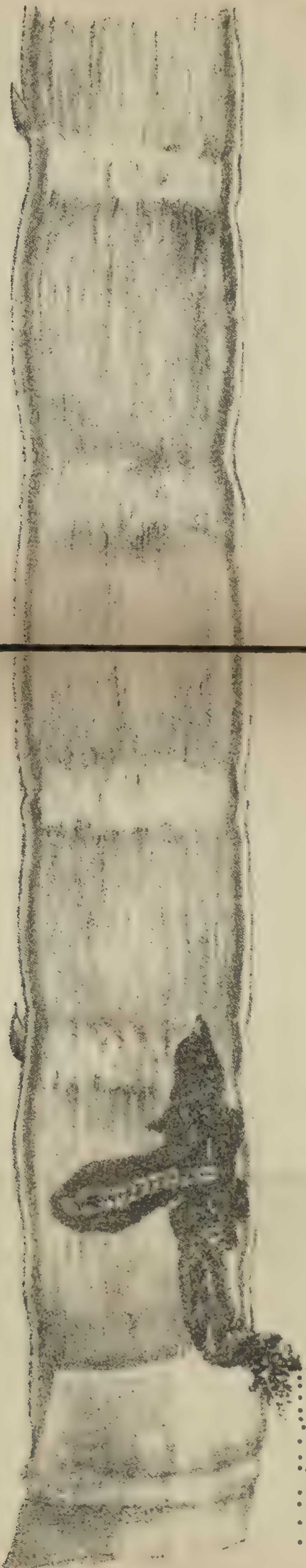
The Members of the Committee full of confidence in the enlightened solicitude of Your Excellency for the agricultural interests of this Colony, leave in your hands the fate of this most important question.

They have the honor to be, with respect,
Your Excellency's
Most obedient humble servants,
W. Bojer, *President.*
Gal. Fropier,
C. C. Brownrigg,
Christian W. Wiehé,
E. de Chazal.

P.S.—Since the drawing up of the above Report the Committee have made a few experiments, which they are desirous should be recorded here. As they are persuaded that it is principally owing to the plantation of cane plants already attacked by the Borer that the propagation of the evil takes place in virgin canes, the Committee have directed their experiments on the most certain and quickest mode of destroying the insect, or its eggs, in the cane tops which are destined to be planted. After immersing these cane tops in water, heated to at least 120° to 125° Fahrenheit, the Committee have acquired the certainty that the Borer was instantaneously destroyed, without the vegetative powers of the plants having suffered in the least degree; for all those treated in that manner have grown perfectly well.

Immersion in cold water is, no doubt, more easy, but, after 24 hours of continued steeping, borers, in appearance dead, quickly recovered, and were ready to continue their work of destruction.

The Committee, desirous of going further and of protecting for some time at least the young plants against the attacks of the Borer, have since tried to add to this hot water a certain proportion of pentasulphide of calcium; one to thirty. Cane plants thus prepared have not suffered in appearance; and, if they grow well as there is every reason to think, it may be hoped that this sulphurous preparation, partly absorbed by the young plant, will have for effect to disgust the Borer, during some months at least. The Committee



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therefore recommend that planters should make experiments with that object in view.

The pentasulphide of calcium, which is not expensive, may be thus prepared :—

To thirty parts by weight of quicklime and 80 parts of flour of sulphur, add 300 to 400 parts of water, which boil together, stirring up until the solution is of a reddish-brown color : let it settle and draw off. This solution is to be added in the proportion of one to thirty to the hot water in which the cane plants are to be immersed for one or two hours. Care must be taken that the water be at 125° at the moment only of immersion, and that it be allowed to cool whilst the plants remain in it. When pentasulphide is used, it is not necessary to remove the leaves from the cane plants—they will, on the contrary, serve to retain a larger proportion of the solution, and thereby assist in attaining the desired object.

The accompanying lithograph represents a bamboo cane 7 feet long, split longitudinally, into which the Borer had penetrated from the inferior part. The cane was fermented and of a red color from the base to the summit. Observed at Savane. This and the two previous plates given in former Numbers of *The Sugar Cane* are of natural size.

## ON SUGAR DETERIORATION.

In the *Sugar Cane*, No. 49, page 413, is an article by Edmund A. Cook, Ph.D., F.C.S., "Concerning Sugar Deterioration."

My attention was first drawn to this subject in the fall of the year 1844. We used to make the best sugar produced in one of the Windward Islands. A strong man with spade or bill-paddle would scarcely make an impression on it, and I have frequently seen sparks fly off when the paddle has come in contact with the sugar in digging out the hogsheads in the curing-house. The last lot was carted off to the shipping bay, where the estate had a mason-work store, without windows, with a rather low roof, and of course little or no ventilation. I had marked the hogsheads previous to carting them. For some cause, which I do not now remember, the sugar was not shipped for some two months after. I was then sent to have the hogsheads refilled and coopered. Now, had I not known they were the same hogsheads, that the mark I put on them was the same, that there was no possibility of their having been changed, I could never have believed it was the same sugar; in fact, had any one brought me a sample of it, I would have declared it impossible.

I have since seen several similar cases when sugars have been stored in badly ventilated buildings. This deterioration is trifling until there is moisture in the atmosphere. I have seen sugars on the stancheons keep their colour for weeks, when shortly after a thunderstorm and heavy rains they have both changed colour, become soft, and commenced throwing off molasses again.

I think all sugars should be passed in the centrifugals, and if possible dried. Planters are apt to imagine that Muscovado sugar loses, or rather throws off too much molasses by this process. I was of this opinion; but the thing is, we then have the molasses in our tank and see it. Whereas in shipping hogsheads of Muscovado sugar we do not see what we lose, and many of us never give it a thought. Muscovado *masse cuite* passed through centrifugals will give more dry sugar than the same quantity would give by the time it reaches Europe.

Another instance occurred here in Porto Rico. A friend of mine, on the North Coast, had a lot of sugar, dark looking, but strong angular grained. A neighbour of his had an equal lot of very pretty whitish sugar One of their customers, an American captain, bought the latter lot, paying a heavier price than he had at first agreed to pay my friend for his. The seller made him a present of a barrel of the choicest, taken from the tops of the hogsheads. A few months after the American returned, bringing with him this barrel of sugar, which had transformed itself into a barrel of clammy stuff, much resembling ashes and molasses. My friend shipped on his own account his lot of dark, but well made hard grained sugar, and it was sold in New York at a far better price than his neighbour's pretty sugar.

I could cite many similar circumstances, but these two are sufficient to point out that we planters do not always forward choice samples to deceive purchasers; the results depend on the sugar itself, and the most experienced sugar purchasers are frequently deceived in their opinion.

A practical, shrewd man, an extensive purchaser here of sugars, dug up a sample from a hogshead and proclaimed it to be really good sugar, and so it was. But turning to some barrels and taking a handful said, but this is inferior stuff. I laughed, and excited his curiosity. The fact was the sugar he had in his hand had been taken from the very hogshead he had been praising. We had the habit of piling up the sugar to form a cone on the hogshead. I had levelled these off a day or two previous, and put the sugar in barrels to dispose of in the neighbouring town, among the Pulperos, and by chance the very barrel he took the sugar from had been filled from that very hogshead. The previous day it had rained; this had not affected the hard, solid sugar of the hogshead, but had made moist what was loose in the barrels.

Round grained, light coloured sugars attract moisture very readily, more so than angular, dark, strong grained sugar; and the sugar-louse present themselves in that class of sugar much sooner. As soon as the louse takes possession of a barrel or hogshead of sugar they speedily spoil its quality, both to the eye and taste.

[We would also direct attention to the letter from Mr. Sturge, in the present number of *The Sugar Cane*, on this subject (see under "Correspondence").—Ed.]

## NEW METHOD OF REMOVING POTASH FROM SACCHARINE SOLUTIONS.

In the manufacture of sugar from various sources, particularly from beetroot, syrups are formed containing large quantities of potash salts, and it is well known that the presence of these salts prevents the separation of a considerable portion of the sugar by the usual process of crystallization. It becomes, therefore, a matter of importance to eliminate this potash, but the methods hitherto proposed for this purpose, whether by dialysis, or by the addition of sulphuric acid followed by that of a large amount of alcohol, have not been attended with any marked success.

The plan now under consideration consists in adding to the cold syrup sulphate of alumina, so as to form an alum with the whole of the potash present. The solution is then well stirred, and after a few hours' standing, the alum separates out in the form of small crystals, technically known as "alum meal," the clear liquor is then run off and immediately neutralized with milk of lime, finishing up with a little chalk, so as to prevent the necessity of removing any excess of lime by carbonatation. It is possible to use chalk only, but the amount of effervescence is then very great, and the chalk should therefore be added little by little.

In working this alum-process the solutions should be quite cold. It is also advisable to operate as quickly as possible, consistently with due separation of the alum, as otherwise more or less sugar would become inverted.

Every one part of potash requires for conversion into alum about 9½ parts of sulphate of alumina, out of which 2½ parts are required to convert the potash into sulphate, and the remaining 7 to combine with the sulphate of potash so as to form alum. If the liquor contains any sulphuric acid, either free or combined, the 2½ parts of sulphate of alumina required to convert the potash into sulphate may be partly or entirely dispensed with.

When once the liquor has been neutralized, it is heated and filtered in the usual way.

The precipitated alum is washed free from syrup with three consecutive washings, using one-third of its weight of water each time. These washings, after neutralizing with lime, are used to dissolve up a fresh quantity of the raw beet sugar.

The alum-meal is easily dried in a centrifugal machine, or by pressure, or other suitable means.

The sulphate of alumina has the following composition :—

| | |
|---|---|
| Alumina .................... | 15·41 |
| Sulphuric Acid................ | 35·99 |
| Water ...................... | 48·60 |
| | 100·00 |

It should be as free as possible from iron, and should not contain more acid than given in the analysis.

The solution of sulphate of alumina generally used contains one-third of its weight of sulphate of alumina, and has a density of about 24° Beaumé.

Instead of using a solution, the dry sulphate of alumina, in a finely-ground state, may be added to a syrup; and when alum separates under these circumstances, the liquor is actually concentrated to some extent.

In operating directly upon beet sugars, they may be dissolved with agitation in a cold solution of sulphate of alumina, containing just sufficient to precipitate the potash.

It is not advisable to operate upon liquors containing less than one per cent of potash, as the alum in such cases, being small in amount, comes down rather slowly. With liquors containing less than one per cent of potash it is better to remove a portion of the sugar by the usual process of refining, and then to treat the residual syrup by the above process.

The rapidity of settlement of the alum is accelerated by throwing into the mixture a quantity of alum meal.

Experiments made with beet syrup from Mr. Duncan's Sugar Works, at Lavenham, and also with various low qualities of beet Sugar from the Continent, have conclusively shown that by means of sulphate of alumina potash may be almost entirely separated from syrups, not more than 0·2 per cent being left in solution. By again concentrating the mother-liquor and repeating the process, the whole of the potash may be practically removed.

The advantages of the process are—

1st. The removal of potash and ammonia from syrups, without much dilution.

2nd. The removal of a great deal of the colouring and albuminous matters, and a considerable improvement both in taste and odour.

3rd. The alum produced is equal in value to the sulphate of alumina used, so that the process is comparatively costless.

4th. The plant required is of the simplest description, the cost of labour small, and the entire process is of a continuous and rapid character.

The ends claimed by this process are:—

1. Effecting the separation of the potash and ammonia existing as salts or compounds in saccharine solutions, by the employment of tartaric acid or of acid tartrates, such as for example the acid tartrate of soda.

2. Effecting the separation of the potash and ammonia existing as salts or compounds in saccharine solutions, by the employment of sulphate of alumina or of a solution of phosphate of alumina in sulphuric acid.

This process is the principal subject of a Patent, No. 2090, Aug. 8, 1871, taken out by Messrs. James Duncan, John A. R. Newlands, and Benj. E. R. Newlands.

## ANALYSIS OF CRUDE SUGARS AND SYRUPS.

By H. Landolt.

*Translated by J. M. Merrick, B.Sc.*

(Continued from page 461.)

### *Determination of the Limits of Error in the Optical Saccharimeter.*

The exactness of which sugar determinations made with a polarizing apparatus are capable, depends upon various circumstances, that are partly conditioned by the instrument itself and are in part independent of it. As concerns the latter the exactness of the determination depends in a measure upon the care exercised in the weighings and measurings necessary in preparing the sugar solution. We can easily be convinced that on this side only the slightest possible error can be introduced. A simple calculation shows that, if in weighing an error of ± ·01 grm. be made, this will produce in Soleil's instrument a difference of observation of only ± ·06, and in Ventzke's saccharimeter of ± ·04 of the scale. The influence which an erroneous volume-measuring can introduce is more important.

If, either through an error in the measuring flask, or by not bringing the fluid exactly to the mark on the neck of the flask, or finally through a considerable alteration of temperature, the volume is made wrong to the amount of 1 c. c., the percentage of sugar will be given wrong to the extent of ± ·4 per cent. on Soleil's scale, and ± 1· on Ventzke's.

A volume-error like that instanced never occurs in practice; at the highest it may amount to ·2 c. c., corresponding to ·08 Soleil, or ·2 Ventzke. Finally, if the observation tube is not exactly 200 mm. long; if, for example, it is ½ mm. too long or too short—a thing that can hardly occur—with the normal solutions for Soleil's and Ventzke's instruments, the rotation of the ray will be given ·25 of a degree too much or too little.

The errors in sugar determinations exhibited in the polarization apparatus, depend partly upon the construction of the instrument itself, and partly upon the unequal sensitiveness of the eye to the recognition of different shades of colour.

With the same observer this is not the same at all times of day and with different persons, as is well known. Specific differences are introduced up to complete colour blindness.

In order to form a judgment about these influences, the following experiments were made:—

*Errors of the Soleil, Ventzke, and Wild Saccharimeters.*

The errors of the three instruments employed for one and the same eye have already been given, and it is further remarked that these are obviously unlike according as the observed fluid is colorless or yellowish, and the eye fresh or already weary.

Since the numbers given refer to unequal masses of fluid, the following, for the sake of a fairer comparison, have been reckoned in degrees of the graduated circle.

The calculation is based upon the fact that in Soleil's apparatus 100, and in Ventzke's 62·77, correspond to a quartz plate 1 mm. thick, and such a plate turns the mean yellow light about 25°.

The smaller, mean, and greater error of each saccharimeter is exhibited in the table and the corresponding quantity of sugar is also given.

The calculation in the last column is made for Wild's instrument, upon the supposition that a solution of 20 grms. sugar in 100 c. c. of water was observed in a 200 mm. tube.

*Saccharimeter.*

| Error of instrument | | | Corresponding amount sugar in grammes to 100 c.c. | Per cent. of sugar in the substance weighed. |
|---|---|---|---|---|
| in scale degrees. | | in degrees of the graduated circle. | | |
| Soleil .. | ± ·2 | ·05 | ·0327 | .2 |
| | ± ·4 | ·10 | ·0654 | ·4 |
| | ± ·8 | ·20 | ·1308 | ·8 |
| Ventzke | ± ·2 | ·08 | ·0521 | ·2 |
| | ± ·4 | ·16 | ·1042 | ·4 |
| | ± ·8 | ·32 | ·2084 | ·8 |
| Wild .. | .... | ± ·02 | ·0151 | ·08 |
| | .... | ± ·04 | ·0301 | ·15 |
| | .... | ± ·10 | ·0753 | ·38 |

From this table it appears that Wild's saccharimeter affords the greatest exactness, Soleil's the next, and Ventzke's is the lowest of the three.

As an advantage of Wild's instrument, may be mentioned the fact that the exactness of observation does not diminish so rapidly with colored solutions as in the other two saccharimeters.

[*Note by Translator.*—Having occasion to make numerous polarizations of sugar, sometimes nearly every day, I provided myself with a Wild's large apparatus of the newest form, made by Hermann and Pfifter of Berne, and sold at a price half as great again as that of the others. After a long and patient series of trials with it, I was obliged to abandon it and fall back upon a Duboscq's Soleil, with which I can do my work satisfactorily.

I should not bring up this fact in the face of the evidence in the text, if it were not for two considerations:—

1st. The importer told me that he had complaints from every purchaser of a Wild's instrument bought of him.

2d. I put the instrument into the hands of all my scientific friends who are in the habit of visiting my laboratory—some of them sugar chemists—and not one could get satisfactory results with it. There was so much uncertainty about the vanishing and reappearing points of the lines that the same observer could never make two coincident observations, nor could two observers agree.

If a Wild's polarizer could be made so that the lines should vanish utterly and then return by moving the graduated circle only one or two divisions, it needs no argument to show that it would be an almost perfect scientific apparatus.

It is fair to say that my experience with it has been confined to only two instruments, my large one, and a smaller one of the earlier pattern.—J. M. M.]

The result of a saccharimetrical determination will obviously be more exact the greater the number of readings that serve to fix the mean.

The following series of observations in which a Ventzke's saccharimeter and a sugar solution of mean concentration was used, was made for the purpose of determining the number of observations that must be made in order to arrive at a tolerably sure result. It shows that ten observations are perfectly sufficient.

1. Mean of 5 observations:—

55·94 ± ·5 .. 55·92 ± ·15 .. 56·34 ± ·15
55·96 ± ·3 .. 56·00 ± ·25 .. 56·12 ± ·35
56·18 ± ·25 .. 56·10 ± ·20 .. 55·88 ± ·15
Deviation from the general mean, ± ·23

2. Mean of 10 observations:—

56·13 ± ·4 .. 56·06 ± ·35 .. 56·04 ± ·4
56·11 ± ·4 .. 56·02 ± ·35 .. 56·03 ± ·35
55·99 ± ·3 .. 56·14 ± ·35 .. 56·00 ± ·35
Deviation from the general mean, ± ·075

3. Mean of 15 observations:—

56·07 ± ·5 .. 56·03 ± ·35 .. 56·05 ± ·35
Deviation from the general mean, ± ·02

4. Mean of all 45 observations, 56·05.

These results can be transferred to the case of the Soleil's saccharimeter without scruple, and, since the error of the instrument remains tolerably constant for all parts of the scale, and occurs alike with normal solutions, they can be regarded directly as percentages. Nevertheless, for exact determination of this instrumental error, the amounts of sugar corresponding to them must be calculated.

We have—

| Exactness as determined by observations. | Grm. in 100 c. c. By Soleil's apparatus. | By Ventzke's apparatus. |
|---|---|---|
| 5 = ± ·23 scale div. | 0·376 | ·0599 |
| 10 = ± ·075 ,, | ·0123 | ·0195 |
| 15 = ± ·02 ,, | ·0033 | ·0052 |

### *Comparative Test of the Three Saccharimeters by Observations made upon the same Solution.*

For these experiments three solutions of pure sugar were employed.

Each of these was tested by the three saccharimeters and so many observations made that the result was certain up to ·2 or ·3 per cent. of the sugar contents of the dry substance.

The following are the resulting figures :—

| | 1 | 2 | 3 |
|---|---|---|---|
| Soleil | 99·97 | 99·90 | 99·68 |
| Ventzke | 99·90 | 99·92 | 99·81 |
| Wild | 100·12 | 100·16 | 99·90 |
| Mean | 100·<br>± ·11 | 99·99<br>± ·11 | 99·80<br>± ·11 |

The error due to the difference of the saccharimeters can be reckoned at ± ·12 per cent of the sugar.

### *Determination of the Personal Error.*

When several observers use the same Soleil's or Ventzke's apparatus, it generally happens that there is a constant difference between the observations.

In order to establish the amount of this difference exactly, it is obviously necessary to make a considerable number of observations and take the mean thereof.

Such a series of experiments shows, first, that the errors of the instrument are unequal for different eyes, and secondly, this individual difference becomes apparent, since each eye finds the uniformity of color of the two discs in one or another point of the scale.

In order to test these differences the following observations were made, in which Drs. Bettendorf, Kemp, and Sollers, and Professor Wüllner had the kindness to assist. A Ventzke's saccharimeter, made by J. G. Greiner, of Berlin was employed, and the observations were uniformly made with the transition tint.

In the first experiments a sugar solution was employed which contained 22·869 grms. pure sugar in 100 c. c.

The readings given with the water tube and sugar tube, 200 mm., are the mean of three series of five consecutive observations.

| Observer. | No. of observations. | Tube with water determination of zero. | Tube with sugar. | Rotation of ray. | Sugar in 100 c. c. | Sugar in per cent. |
|---|---|---|---|---|---|---|
| Wüllner .. | 15 | —·45±·30 | 87·14±·26 | 87·59 | 22·8154 | 99·77 |
| Bettendorf.. | 15 | —·29±·41 | 87·39±·49 | 87·68 | 22·8389 | 99·87 |
| Kemp .... | 15 | —·11±·45 | 87·74±·40 | 87·85 | 22·8832 | 100·06 |
| Zollers .... | 15 | +·22±·33 | 88·15±·40 | 87·93 | 22·9040 | 100·15 |
| Landolt .. | 15 | +·59±·28 | 87·92±·35 | 87·33 | 22·7477 | 99·47 |
| Mean .... | 75 | +·01 | 87·67 | 87·68 | 22·8378 | 99·86 |
| Error .... | .. | ±·52 | ±·50 | ±·50 | ±·0782 | ±·34 |

In a second series of observations the essays were made simply with a tube filled with sugar solution, the zero being taken as uniform and correct for all the observers. The amount of sugar in the solution used was unknown; in calculating the sugar contents, the dry substance gave a mean, as unity, from the whole number of observations.

| Observer. | No. of observations. | Mean of rotation observer. | General Mean. | Sugar in grammes to 100 c.c. | Sugar in per cent. |
|---|---|---|---|---|---|
| W. | 10 | 55·31±·35 | 55·34±·03 | 14·4150 | 99·46 |
| | 10 | 55·37±·35 | | | |
| | 10 | 55·34±·50 | | | |
| B. | 10 | 55·06±·50 | 55·07±·09 | 14·3446 | 98·98 |
| | 10 | 54·99±·25 | | | |
| | 10 | 55·17±·45 | | | |
| K. | 5 | 55·58±·45 | 55·68±·10 | 14·5035 | 100·07 |
| | 5 | 55·78±·35 | | | |
| T. | 5 | 56·00±·50 | 56·05±·05 | 14·5999 | 100·74 |
| | 5 | 56·10±·60 | | | |
| L. | 15 | 56·07±·50 | 56·05±·02 | 14·5999 | 100·74 |
| | 15 | 56·03±·35 | | | |
| | 15 | 56·05±·35 | | | |
| Mean. . | 125 | . . . . . . . . | 55·64 | 14·4930 | 100·00 |
| Error. . | . . | . . . . . . . . | ±·50 | ±·1276 | ±·88 |

From these two tables it is seen that the results which different observers obtain with Ventzke's saccharimeter may differ from the mean about ±·50 of a division.

This error remains in all parts of the scale the same, since the colour is always the same [colour of the discs.—Tr.], and therefore when the zero has been determined for each eye, as in the first series of experiments, the rotations of the ray by the sugar solution are found to be accordant. Yet table No. 1 gives a deviation of ±·3 that may depend in part upon the ordinary error of observation. If the zero is left out of the account the discrepancy among the different observers amounts to ·5 of a division, or, with the normal solution to ·5 per cent. of the dry substance.

In a diluted fluid—such, for example, as that employed in series 2—the influence of this error upon the calculation of the amount of sugar is naturally greater, amounting here to ·88 per cent.

The above experiments show, further, that there is a definite individual difference of the eye in relation to uniformity of colour. If the five observers be arranged according to the direct readings obtained, we have the following series which agree very closely:—

| SERIES. | | LOWEST READING. | | | | HIGHEST READING. |
|---|---|---|---|---|---|---|
| 1. | Water | W | B | K | T | L |
| | Sugar | W | B | K | L | T |
| 2. | Sugar | B | W | K | T | L |

With Wild's polarizer it is probable that the personal error would mostly disappear, since in this the eye has not to make a comparison of shades of color, but only to observe the disappearance of the black lines of interference, and the appearance of the bright spot upon the crossed threads. The following series of experiments show, in fact, that this instrument gives a considerably closer agreement in the readings of different observers than Soleil's or Ventzke's.

A solution of 23·210 grms. of pure sugar in 100 c.c. was employed, and the rotation of the ray determined in a tube 200 mm. long in homogeneous light.

The readings were taken in one quadrant, the experiment being simply to test the observers, and six consecutive observations were made, the mean of which is given in the table in next page.

These experiments give the difference between the determined rotation of the ray as merely ±·0575, which in the solution used corresponds to ·0433 grm. of sugar in 100 c. c., or to 19 per cent. of the dry substance.

The ordinary mean error of the instruments, 40°, is very little expected.

With Wild's polarizer, therefore, we hardly need consider the individual error, especially when the series of observers arranged according to the increment of the angle of rotation shows no agreement whatever. Thus

Tube with water N. .. K. .. L. .. T. .. B.
,, ,, sugar B. .. W. .. L. .. T. .. K.

| Ob-server. | No. of ob-servations. | Tube with water. | Tube with sugar. | Angle of rotation. | Sugar in 100 c. c. | Sugar in per cent. |
|---|---|---|---|---|---|---|
| K. | 6 | 90·280 | 59·547 | 30·679° | 23·0952 | 99·89 |
| | 6 | 90·147 | 59·547 | | | |
| | 6 | 90·253 | 59·547 | | | |
| Mean | 18 | 90·226±·066 | 59·547± ·00 | | | |
| L. | 6 | 90·230 | 59·583 | 30·686° | 23·1004 | 99·92 |
| | 6 | 90·213 | 59·533 | | | |
| | 6 | 90·250 | 59·520 | | | |
| Mean | 18 | 90·231±·018 | 59·545± ·03 | | | |
| W. | 6 | 90·193 | 59·487 | 30·708° | 23·1170 | 99·99 |
| | 6 | 90·180 | 59·493 | | | |
| | 6 | 90·200 | 59·470 | | | |
| Mean | 18 | 90·191±·010 | 59·483±·011 | | | |
| T. | 6 | 90·280 | 59·537 | 30·721° | 23·1268 | 100·03 |
| | 6 | 90·307 | 59·550 | | | |
| | 6 | 90·193 | 59·530 | | | |
| Mean | 18 | 90·260±·057 | 59·539±·010 | | | |
| B. | 6 | 90·257 | 59·467 | 30·794° | 23·1817 | 100·27 |
| | 6 | 90·250 | 59·477 | | | |
| | 6 | 90·283 | 59·463 | | | |
| Mean | 18 | 90·263±·016 | 59·469±·007 | | | |
| Gen m'n | 90 | 90·234° | 59·5165° | 30·7175° | 23·1242 | 100·02 |
| Error | 2 | ±·036 | ±·039 | ±·0575° | ±0·433 | ± ·19 |

The following table I. [page 551] contains only the *results of the polarization of the whole crude beet-root sugar* employed in the experimental refining. In reference to this the following remarks may be made :—

1. For the determinations by the different saccharimeters the rule adopted was to weigh out a special quantity of crude sugar for each instrument ; the differences apparent in the results are to be referred to some inequality in the substance itself.

The samples taken out of different parts of the cask, and well mixed, were kept in two pound flasks, and the substance to be weighed taken out of the middle of these lots.

### Table I.

| No. of sample. | Wild's Saccharimeter. Landolt. | Ventzke's Saccharimeter. Landolt. | Soleil's Saccharimeter. | | | | | | Mean value adopted. | | Polarization at Köln. | Polarization at Magdeburg. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Landolt. | | Lotman. | | Lotman & Landolt. | | | | | |
| | | | Direct | Invrtd | Direct | Invrtd | Direct | Invrtd | Direct | Invrtd | | |
| 1 | .. | 94·5 | 95·7 | 95·0 | 95·2 | 95·0 | .. | .. | 95·4 | 95·0 | 95·0 | 96·1 |
| 2 | .. | 93·4 | 92·8 | 93·0 | 93·0 | 93·0 | .. | .. | 93·0 | 93·0 | 93·2 | 93·2 |
| 3 | 94·9 | 94·5 | .. | .. | 93·0 | 93·0 | 94·5 | 94·3 | 94·5 | 94·3 | 94·5 | 94·7 |
| 4 | 93·5 | 92·4 | 93·3 | 93·0 | 92·0 | 92·5 | 93·5 | 93·5 | 93·4 | 93·5 | 92·9 | 92·6 |
| 5 | 94·7 | 94·0 | .. | .. | 95·0 | 94·5 | 94·8 | 94·4 | 94·9 | 94·4 | 94·1 | 94·5 |
| 6 | 93·9 | 92·3 | 93·0 | 93·1 | 93·5 | 93·0 | 94·5 | 93·1 | 94·0 | 93·1 | 94·0 | 95·6 |
| 7 | 92·9 | 92·1 | 91·9 | 91·8 | 91·8 | 92·1 | .. | .. | 91·9 | 92·0 | 92·4 | 93·6 |
| 8 | 93·9 | 93·7 | 93·0 | 93·4 | 93·7 | 93·5 | .. | .. | 93·7 | 93·5 | 93·0 | 94·4 |
| 9 | .. | 93·5 | 93·7 | 93·6 | 93·6 | 93·5 | .. | .. | 93·6 | 93·5 | 94·7 | 96·5 |
| 10 | .. | 91·9 | 92·0 | 92·0 | 94·0 | 92·0 | .. | .. | 92·0 | 92·0 | 92·1 | 92·7 |
| 11 | 93·6 | 92·1 | .. | .. | 93·5 | 93·2 | 93·3 | 93·1 | 93·4 | 93·1 | 93·1 | 93·1 |
| 12 | 94·4 | 93·9 | 93·9 | 93·9 | 93·7 | 94·0 | .. | .. | 93·8 | 94·0 | 93·5 | 93·5 |
| 13 | 91·9 | 91·8 | 91·8 | 92·1 | 92·0 | 92·0 | .. | .. | 91·9 | 92·0 | 91·3 | 93·2 |
| 14 | 93·1 | 92·1 | 92·7 | 92·0 | 90·5 | 90·0 | 93·2 | 92·0 | 93·0 | 92·0 | 92·0 | 93·2 |
| 15 | .. | 92·5 | 93·3 | 92·0 | 94·0 | 93·7 | 94·0 | 93·7 | 94·0 | 93·7 | 92·5 | 94·0 |
| 16 | .. | 91·8 | .. | .. | 91·2 | 91·8 | .. | .. | 91·5 | 91·8 | 92·5 | 92·9 |
| 17 | 92·9 | 92·5 | .. | .. | 92·8 | 93·0 | .. | .. | 92·8 | 93·0 | 92·3 | 92·7 |
| 18 | 94·3 | 93·5 | .. | .. | 94·0 | 93·4 | .. | .. | 93·8 | 93·4 | 93·8 | 94·1 |
| 19 | .. | 92·7 | 92·7 | 92·7 | 92·5 | 93·0 | .. | .. | 92·6 | 93·0 | 93·2 | 93·4 |
| 20 | 93·4 | 92·9 | 93·2 | 93·0 | 93·0 | 93·0 | .. | .. | 93·2 | 93·0 | 92·7 | 94·2 |
| 21 | 93·9 | 93·6 | 93·4 | .. | 93·5 | 93·0 | .. | .. | 93·5 | 93·0 | 93·5 | 94·1 |
| 22 | 92·6 | 90·5 | 90·9 | 90·0 | 93·0 | 92·0 | 92·5 | 91·6 | 92·8 | 91·6 | 92·7 | 94·7 |
| 23 | 90·3 | 90·4 | .. | .. | 91·0 | 90·7 | .. | .. | 90·6 | 90·7 | 90·0 | 90·6 |
| 24 | .. | 92·2 | .. | .. | 93·3 | 93·5 | 94·0 | 93·8 | 93·6 | 93·8 | 93·4 | 94·6 |
| 25 | .. | 92·1 | .. | .. | 92·0 | 92·5 | .. | .. | 92·0 | 92·5 | 92·8 | 94·0 |
| 26 | 90·5 | 90·6 | 90·6 | 90·0 | 91·0 | 90·0 | .. | .. | 90·8 | 90·0 | 90·1 | 90·5 |
| 27 | .. | 91·0 | 91·8 | 92·0 | 90·6 | 90·6 | .. | .. | 91·1 | 91·3 | 91·5 | 93·7 |
| 28 | .. | 91·5 | 92·5 | 92·5 | 92·0 | 92·4 | .. | .. | 92·0 | 92·4 | 91·4 | 91·8 |
| 29 | 90·7 | 89·4 | 90·3 | 89·4 | 89·0 | 89·5 | .. | .. | 89·2 | 89·5 | 90·4 | 91·7 |
| 30 | .. | 91·7 | 91·3 | 91·9 | 91·0 | 92·0 | .. | .. | 91·3 | 92·0 | 92·9 | 92·3 |
| 31 | 91·0 | 89·7 | 90·3 | 89·2 | 90·5 | 90·0 | .. | .. | 90·4 | 89·6 | 90·2 | 91·4 |
| 32 | .. | 89·3 | 89·4 | 88·9 | 89·5 | 89·0 | .. | .. | 89·4 | 89·0 | 90·6 | 90·7 |
| 33 | .. | 86·6 | 86·8 | 86·9 | 86·7 | 87·0 | .. | .. | 86·7 | 87·0 | 88·4 | 86·6 |

By long standing of these bottles, with occasional opening, the sugar on the surface lost water, while, on the contrary, the lower parts took up moisture as might be seen by their changed appearance.

That the standing of the bottles for several weeks caused a difference in the sugar contents of the samples taken therefrom, is shown by an experiment made with crude sugar No. 5, viz. :—

A sample from upper layer = 94·00 per cent. sugar.
,, ,, ,, middle ,, = 93·80 ,, ,, ,,
,, ,, ,, lower ,, = 93·70 ,, ,, ,,

Hence the possible error due to the variation of the sample may be from 1 to 3 per cent.

2. Polarizations were made not only by myself but by Herr Lotman, of Amsterdam. In most cases the results agreed very closely, and the table furnishes a proof that the various above investigated errors with which saccharimetrical determinations may be burdened, very frequently neutralize each other. If we take the difference between the highest and lowest direct polarization of each sugar, and find the mean value of the 33, we get the number 97.—*Journal für pracktische Chemie, CIII.*

*(To be continued.)*

## Correspondence.

### SUGAR DETERIORATION.

Birmingham, 25, 8, 1873.

To the Editor of "The Sugar Cane."

Sir,

It is very satisfactory to learn from your August number that scientific attention is being directed to the change that takes place in raw sugar during the voyage from the place of production to Europe.

This occasional deterioration in cargoes of Muscovado and Concrete, causes more annoyance both to planters, merchants, and buyers than anything else connected with the trade. If the cargo is sold after landing, the grower, when he sees his sugar sold at a lower price than that realised for his neighbour's produce, thinks that the merchant has failed in obtaining a fair value for his goods; if sold by shipped sample and the bulk proves inferior, then the buyer thinks himself ill-used by the seller, and in either case, the loser throws the blame on the merchant.

In any enquiry into the causes of this deterioration, the first step is to determine the circumstances under which it occurs. My experience is mainly confined to one of the smaller West Indian islands, in which the variation of temperature does not exceed 17 degrees; yet our importations are as liable to suffer as those from any of the other islands. During the shipping season of 1872, the highest point registered in the shade at mid-day being 88° Fahrenheit, and the lowest at night 71°, the mischief could hardly arise from extremes of heat and cold during shipment.

Moreover, when two cargoes are shipped in succession, the sugar being from the same estates, the loading of the second vessel beginning directly that of the other is finished, the condition of the two on arrival may be quite dissimilar. In some seasons, the present for instance, there is a great complaint of deterioration; in others, very little; indicating that the state of the weather, either during the process of manufacture or whilst the cane is growing, has an important bearing on the question.

The next point for consideration is the influence of the soil upon which the cane was grown; whether all Muscovado sugars are equally liable to suffer, or only the produce of one description of soil? Does the produce of the calcareous soils of Barbadoes and Antigua, of the alluvial plains of Trinidad and Porto Rico and of the volcanic *débris* of St. Kitts, Nevis, and Montserrat, all deteriorate alike? It is well known that the difficulties in the manufacture of sugar vary with the nature of the soil on which the cane is grown; and it is possible that the produce of some soils may likewise be more liable than that of others to be affected by being kept for a month or more in the close, steaming hold of a vessel; just as some samples of raw sugar when kept in close stoppered bottles turn acid sooner than others.

This is, however, a question the solution of which I must leave to those who can give the result of their experience as to the effect of the voyage on sugar made in different colonies.

Yours, &c.,

C. D. Sturge.

## Stocks of Sugar in the Chief Markets of the World on the 1st August, for Three Years, in thousands of tons, to the nearest thousand.

| | 1873. | 1872. | 1871. |
|---|---|---|---|
| Great Britain | 190 | 124 | 171 |
| France | 76 | 39 | 50 |
| Holland | 4 | 3 | 4 |
| Germany (Zollverein) | 59 | 36 | 41 |
| Six other *entrepôts* | 9 | 5 | 5 |
| Total in Europe | 338 | 207 | 271 |

## Consumption of Sugar in Europe and the United States, for Three Years ending 1st August, in thousands of tons.

| | 1873. | 1872. | 1871. |
|---|---|---|---|
| Great Britain | 661 | 689 | 705 |
| France | 381 | 273 | 263 |
| Germany (Zollverein) | 150 | 201 | 220 |
| Holland | 147 | 23 | 26 |
| Six other *Entrepôts* | 63 | 89 | 113 |
| Total in Europe | 1,402 | 1,275 | 1,328 |

## Estimated Crop of Beet Root Sugar on the Continent of Europe, for the ensuing Season, compared with that of the three previous Seasons.

*(From Licht's Monthly Circular.)*

| | 1872-73.<br>Tons. | 1871-72.<br>Tons. | 1870-71.<br>Tons. | 1869-70.<br>Tons. |
|---|---|---|---|---|
| France | 395,000 | 335,000 | 289,000 | 289,000 |
| Germany (Zollverein) | 260,000 | 189,000 | 263,000 | 217,000 |
| Austro-Hungary | 205,000 | 162,000 | 182,000 | 151,000 |
| Russia and Poland | 150,000 | 90,000 | 135,000 | 133,000 |
| Belgium | 80,000 | 72,000 | 56,000 | 44,000 |
| Holland and other Countries | 35,000 | 25,000 | 17,000 | 12,000 |
| Total | 1,125,000 | 873,000 | 942,000 | 846,000 |

## SUGAR STATISTICS—GREAT BRITAIN.

To 13th September, 1873 and 1872. In Thousands of Tons, to the Nearest Thousand.

| | STOCKS. | | | | | | IMPORTS. | | | | | | DELIVERIES. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. |
| British West India | 35 | 4 | 2 | 32 | 73 | 75 | 85 | 16 | 11 | 49 | 161 | 148 | 67 | 13 | 11 | 33 | 124 | 94 |
| British East India | 14 | 2 | .. | .. | 16 | 8 | 19 | 4 | .. | .. | 23 | 17 | 15 | 5 | .. | .. | 20 | 15 |
| Mauritius ...... | 2 | 1 | .. | .. | 3 | 4 | 12 | 3 | 12 | 11 | 38 | 37 | 13 | 3 | 12 | 12 | 40 | 39 |
| Cuba .......... | 4 | 8 | 3 | 27 | 42 | 45 | 8 | 13 | 17 | 52 | 90 | 101 | 9 | 7 | 15 | 37 | 68 | 65 |
| Porto Rico, &c. .. | 2 | 12 | .. | 4 | 18 | 13 | 4 | 26 | 1 | 13 | 44 | 27 | 4 | 17 | .. | 8 | 29 | 18 |
| Manilla & Java .. | 28 | 8 | .. | 2 | 38 | 15 | 24 | 9 | 7 | 6 | 46 | 40 | 17 | 6 | 7 | 8 | 38 | 48 |
| Brazil .......... | 3 | 27 | 2 | 5 | 37 | 23 | 11 | 59 | 5 | 11 | 86 | 77 | 9 | 45 | 4 | 11 | 69 | 69 |
| Beetroot, &c. .... | 2 | .. | .. | .. | 2 | 2 | 25 | 8 | 6 | 18 | 57 | 59 | 29 | 10 | 8 | 29 | 76 | 71 |
| Total, 1873 .. | 90 | 62 | 7 | 70 | 229 | 185 | 188 | 138 | 59 | 160 | 545 | 506 | 163 | 106 | 57 | 138 | 464 | 419 |
| Total, 1872 .. | 69 | 35 | 9 | 72 | 44 increase | | 148 | 108 | 60 | 190 | 39 increase | | 120 | 99 | 57 | 143 | 45 increase | |

## STATE AND PROSPECTS OF THE SUGAR MARKET.

During the past month the most notable feature in the sugar market has been the sudden and remarkable stagnation in the refined trade, which set in very early in the month, and the premonitory symptoms of which were alluded to in our last report. The cause of this sudden and considerable depression is not difficult to assign—it cannot be traced to any falling off in the consumption, and it can scarcely be doubted that the continuous inundation of our refined markets with Foreign sugar, at prices abnormally and ruinously low, has at length told its tale. The effects have been felt by our refiners, and manifested by a diminution, or in some cases by a cessation of work, and although the crisis is now passed, and a moderate business in refined is being transacted, the result is apparent in a reduction in the price of both loaf and crushed of 1s. 6d. to 2s., and in the lower qualities pieces of 2s. 6d. to 3s.

A very peculiar and noteworthy feature however in this general decline is to be found in the steady attitude of the Raw market. Notwithstanding that the statistics of this month show no sensible abatement in the amount of stock, and although the actual business transacted has been restricted, holders have continued firm in their demands and little quotable change can be said to have occurred.

No. 12 Havana afloat is quoted at 26s. 6d. to 27s. per cwt., against 27s. at the end of August; fair to good refining Muscovadoes, at 21s. 6d. to 22s. 6d., show no change, whilst middling to good brown Bahia is worth 17s. 6d. to 18s. 6d., against 18s. to 19s. Some reason for the comparative firmness of Raw is to be found in the circumstance that the stock of low sugar, especially in London, bears an unusually large proportion to the whole, and as low sugars are at present almost neglected by refiners, these find their choice more limited. The high price of malt, on the other hand, disposes brewers to enter the sugar market for low sorts.

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SUGAR CANE.

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☞ The writers alone are responsible for their statements.

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# UPON THE ACTION OF WATER AND VARIOUS NEUTRAL SALT SOLUTIONS UPON CANE SUGAR.

### By Dr. W. L. Clasen.

*Erdman's Journ. Prakt. Chem.*, 103.
*Translated for the Amer. Chem. by J. M. Merrick, B.Sc.*

That cane sugar suffers a molecular change under the influence of water and heat which resembles that brought about by diluted acids, was first shown by Soubeiran.* Later Berthelot † showed that cane sugar heated to 100° C. with water, is gradually changed into grape, *i. e.*, fermentable sugar, and that this reaction is considerably hastened by the presence of chloride of calcium and chloride of ammonium.

Maumené ‡ pointed out the similar fact that cane sugar in contact with pure cold water gradually goes over into grape sugar. We owe the most extensive researches upon this subject to Bechamp,§ who observed the influence of pure water and of solutions of various salts upon sugar. He obtained almost the same results as the previously mentioned investigators, *i.e.*, he could show that cold water gradually changes cane sugar into glucose, but at the same time he arrived at the highly noteworthy results, viz., that the presence of certain neutral salts prevented this change, either wholly or in part. Bechamp came to the conclusion that the change of cane sugar into glucose is really conditioned by some mould formation [schimmelbildung] that goes on in the solution.

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* Journ. de Phar. [3] 1, 469. Erd. Journ. Prakt. Chem. 27, 281. Biot. Compt. Rend. 16, 528.

† Ann. de Chim. et Ph. 83, 106.

‡ Transformation du sucre de canne par l'action de l'eau pure. Compt. Rend., 39, 914.

§ Sur l'influence de l'eau pure, etc., sur le sucre de canne. Compt Rend., 40, 436. Erdmann's Journ. Prakt. Chem., 74, 459; 69, 433.

By my own experiments, to be be mentioned later, I have controverted essentially the observations of Bechamp, to which I shall return; but I have sought to exhibit in another and safer way a proof of the molecular alteration of cane sugar and its change into fruit sugar.

Bechamp confined himself to showing the change by a lessening of the rotation of the plane of polarization, and since some of his salt solutions produced an almost constant diminution of rotation, he believed himself obliged to conclude not that there was a formation of fruit sugar, but that there was a similar rotation-diminishing combination of these salts with cane sugar, such as was earlier shown by Biot in the case of tartaric and boracic acids with sugar, and later by Sostmann* in caustic alkalies and sugar.

I convinced myself of the formation of fruit sugar as well by the capacity of the sugar solution to reduce Fehling's alkaline copper liquid as by the diminution of rotation.

In every case a reduction occurs, is confirmed the fact that a molecular alteration of the cane sugar has taken place.

At the same time I examined sugar solutions with and without salts, and not only by allowing them to stand at ordinary temperatures, but by investigating their capacity of reduction with the aid of heat.

In no case did my experiments last so long as those of Bechamp. He allowed sugar solutions to stand from 9 to 17 months, and examined them from time to time.

In this case the formation of mould is inevitable, and we have only to decide whether the sugar has been infested by the mere influence of water and salts or the fungi formed have acted as a ferment.

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* Zeitschrift für Rubenzacker fabk. 16, 272.

The maximum duration of my experiments was five days, and in this time no trace of the formation of mould was to be detected.

Only thus did it seem to me possible to obtain a result which should not be influenced by the rapid formation of fungi in the solution. On the basis of these experiments I came to the conclusion that cane sugar in the presence of pure water as well as certain salts, gradually changes into fruit sugar, and not in consequence of a formation of mould; but apparently in consequence of a reaction similar to that of diluted acids upon sugar.

I refer briefly to Bechamp's experiments, first in order, to be able to directly compare his results with my own, to be given further on.

### BECHAMP'S EXPERIMENTS.

Bechamp's first paper appeared in 1855. He limited himself at that time to the investigation [of the action] of pure water, and water containing chloride of zinc and chloride of calcium, upon cane sugar.

The amount of rotation of the ray was measured by a Soleil's saccharimeter with tubes 200 mm. long.

| 16·365 grms. sugar dissolved in 100 c.c. of the following fluids. | Rotation of Plane of Polarization. | | | | | |
|---|---|---|---|---|---|---|
| | 1854. | | | | | 1855. |
| | 16 May. | 17 May. | 20 May. | 15 June. | 20 Aug. | 5 Feb. |
| | 15°C. | 16°C. | 16°C. | 18°C. | 21°C. | 4·5°C. |
| Distilled water .... | 23·88 | 23·47 | 22·85 | 22·39 | 17·28 | 7·80 |
| Zinc-chloride ...... | 22·32 | 22·20 | 22·10 | 22·14 | 22·27 | 22·28 |
| Chloride of calcium.. | 22·34 | 22·15 | 22·10 | 22·08 | 22·14 | 22·28 |
| ,, ,, ,, | 22·34 | 22·13 | 22·17 | 22·25 | 22·22 | 22·29 |

Bechamp's full treatise upon this subject appeared in 1859. In this he sets forth three series of experiments which were undertaken by him upon the influence of pure water and various salt solutions upon cane sugar. The first is the one already mentioned. In the second Bechamp sought to prevent the possible influence of mould formation by the addition of the acids of arsenic, chloride of mercury, and creasote. According to his experiments, bodies which prevent the forming of mould diminish the rotating power of the sugar solution.

In the third series, water that had been boiled and kept from access of the atmosphere was employed. No mould was developed and the rotatory power was undiminished.

All the experiments of Bechamp, when the formation of fungi showed itself—and these are the most numerous—leave us in uncertainty about the influence of the salts in question upon cane sugar, because with a polarizer we cannot show whether a change in the sugar solution did not begin before the formation of fungi which was completed by their fermentation.

The main result of Bechamp's research is that cold water does not alter cane sugar, and that any such change is probably merely the consequence of a formation of mould acting as a ferment.

### CLASEN'S RESEARCHES.

About the method of investigation and the nature of the reagents, I make the following remarks.

Good refined sugar, whose percentage in chemically pure sugar had been previously determined, was used for the solutions. These solutions contained on an average about 10 per cent. of sugar, and the salts employed were added in very small amount in order to establish, so far as possible, the relation between the two that exists in beet juice.

As a normal amount, 0·2 grm. of gypsum was added to 100 c. c. of the sugar solution, and the other salts were employed in amounts equivalent to the gypsum.

The determinations of the sugar were made with a Ventzke's-Soleil apparatus, which gave 100° of right polarization with the use of tubes 200 mms. long, and a solution of 26·048 grms.

chemically pure sugar in 100 c.c. of water.

The altered sugar solutions were tested with litmus paper. The change occurring in them was tested both by the polarimeter and by their action upon Fehling's solution.

To this end 5 grammes of the solution to be investigated were diluted to about 100 c. c. and heated to 70° to 80° for two hours with 10 c. c. of Fehling's solution of which 1 c. c. correspond to ·005 grm. of fruit sugar.

The separated suboxide of copper was estimated by means of a very dilute chameleon solution. The reduced sugar was reckoned as anhydrous grape sugar $C_{12}H_{12}O_{12}$.

The sugar employed was always first tested with Fehling's solution for any possible trace of grape sugar.

Only when after two hours' heating of the blue solution no reduction of the copper was remarked, was the sugar considered proper for the use of this research.

In polarizing, the mean of three successive well agreeing observations was taken as a final result. The error of observation amounted in the various experiments from ·1° to ·2°.

In the whole three series of observations were made, and observations were made at ordinary temperatures as well as at temperatures more elevated.

The action [of the salts] was never continued longer than five days, since the formation of mould always began after this lapse of time. In this research no such formation was noticed.

### FIRST SERIES.

The sugar employed showed by the polarimeter 98·5 per cent. $C_{12}H_{11}O_{11}$, the rest being moisture. No ponderable residue was left on burning the sugar. The solution of the sugar was made at the ordinary temperature. Of this sugar 100 grms. were dissolved in 1000 c.c. of water. Examination of the solution gave—

| POLARIZATION DEGREES. | | PER CENT. SUGAR. | | |
|---|---|---|---|---|
| Calculated. | Found. | Calculated. | Found. | Difference. |
| 37·81* | 37·7 | 9·49 | 9·46 | ·03 |

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* Thus, 26·048 : 100 :: 9·85 : $x$.

Of this solution 100 c. c. were employed for each experiment, and the solutions which had stood in the air were made up to 100 c. c. before the experiment.

The solutions were kept in beaker-glasses of equal size covered with filter paper. The experiments of this series divide themselves into three groups according to the duration and kind of action, viz.:—

1. Examination of the pure solution immediately after preparation.

2. Examination of the solution after standing three days at the ordinary temperature.

(In this case were employed—
*a.* Pure solution.
*b.* ,, ,, with gypsum.
*c.* ,, ,, ,, and chloride of ammonium.†)

| | *a* | | | *b* | *c* | *d* | *e* | *f* |
|---|---|---|---|---|---|---|---|---|
| | Pure solution as soon as made. | | | 100 c.c. pure solution. | = *b* + ·2 grm. CaO.SO$_3$. | = *c* + 1·57 grms. NH$_4$Cl. | After 5 days standing and 3 hours' heating at 70° R. | |
| | Calculated. | Found. | Difference. | 3 days standing at ordinary temp. | | | | |
| Reaction .... | neut. | neut. | neut. | neut. | neut. | neut. | neut. | w'kly acids. |
| Polarization .. | 37·81 | 37·7 | ·11 | 37·7 | 37·8 | 37·8 | 37·5 | 34·6 |
| Cane sugar .. | 9·49 | 9·46 | ·03 | 9·46 | 9·49 | 9·49 | 9·41 | 8·72 |
| Invert. sugar.. | ·00 | ·00 | ·00 | ·025 | ·00 | ·000 | ·021 | ·454 |

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† Here belongs the remark made by Stammer (Dingl. Polyt. Journ. 161,139), that, by separately boiling neutral sugar solutions containing gypsum and chloride of ammonium and then mingling the two, a strongly acid solution is obtained in a short time.

3. Examination of the solution after standing five days at the ordinary temperature, and then three or four hours' heating in the water-bath to 70° R., the water being renewed as it evaporated. The composition of the solutions employed was as 2, *b*, etc., above.

It is to be remarked that the gypsum employed in this experiment contained sulphide of calcium, and that therefore at the beginning there could be perceived a weak evolution of sulphydric acid, and a slightly alkaline reaction. After a short boiling, the reaction was at first neutral and afterwards weakly acid.

### SECOND SERIES.

The sugar employed that had been tested and used in the first series showed 99·1 per cent. of chemically pure sugar. It contained no grape sugar and left no residue upon ignition.

A solution of 100 grms. of this sugar in 1000 c. c. of water gave—

| POLARIZATION DEGREES. | | PER CENT. SUGAR. | | |
|---|---|---|---|---|
| Calculated. | Found. | Calculated. | Found. | Difference. |
| 38·05 | 38·0 | 9·55 | 9·54 | ·01 |

The experiments in this series, with the exception of *e* (made by way of control), were made in such a way that 100 c. c. of the solution, immediately after preparation, with regard to the forementioned precautions, was heated 3 to 4 hours to 80° R. in order to see in this case whether a decomposition showed itself as in the case of the solutions which after five days' standing were heated to this temperature.

These solutions were:—

1. Pure solution.
2. ,, ,, + gypsum.
3. ,, ,, + chloride of ammonium.
4. ,, ,, + chloride of sodium.
5. ,, ,, + ,, ,, and gypsum.

The following are the results:—

| | *a* | | | *b* | *c* | *d* | *e* | *f* | *g* |
|---|---|---|---|---|---|---|---|---|---|
| | Pure solution immediately after preparation. | | | 100 c.c. pure solution. | $= b + \cdot 2$ grm. $CaO.SO_3$ | $= c + \cdot 157$ grm. chlor. of ammon. | 100 c.c. pure sol. 3 days of ord. temp. | 100 c.c. $+ \cdot 172$ grm. NaCl. | $= f + \cdot 2$ grm. $CaO.SO_3$. |
| | Calculated. | Found | Difference. | Heated 3 hours at 70° R. | | | | | |
| Reaction .... | neut. | neut. | neut. | neut. | neut. | weak acid. | neut. | neut. | neut. |
| Polarization.. | 38·05 | 38·0 | ·05 | 38·0 | 37·9 | 36·6 | 38·0 | 37·9 | 37·5 |
| Cane sugar .. | 9·55 | 9·54 | ·01 | 9·54 | 9·51 | 9·20 | 9·54 | 9·51 | 9·41 |
| Invert. sugar | ·00 | ·00 | .. | ·00 | ·00 | ·08 | ·021 | ·00 | traces. |

### THIRD SERIES.

The refined sugar used was 99·25 pure, and gave an ash = 0. The solution gave—

| POLARIZATION DEGREES. | | PER CENT. SUGAR. | | |
|---|---|---|---|---|
| Calculated. | Found. | Calculated. | Found. | Difference. |
| 38·1 | 38·0 | 9·56 | 9·54 | ·02 |

For experiment were used—

1. Solutions that had stood three days at the ordinary temperature, viz. :—

*a.* Pure solution.
*b.* ,, ,, + nitrate of potash.
*c.* ,, ,, + sulphate of magnesia.

2. Solutions which after five days' standing at ordinary temperatures had been heated 3 to 4 hours to 70° R.

*a.* Pure solution + nitrate of potash.
*b.* ,, ,, + sulphate of magnesia.

| | a | | | b | c | d | e | f |
|---|---|---|---|---|---|---|---|---|
| | Pure solution immediately after preparation. | | | 100 c.c. pure solution. | 100 c.c.+ ·297 grm. $KO.NO_5$. | 100 c.c.+ ·176 grm. $MgO.SO_3$. | 100 c.c.+ ·297 grm. $KO.NO_5$. | 100 c.c.+ ·176 grm. $MgO.SO_3$. |
| | Calculated. | Found | Difference. | Left 3 days at ordinary temperature. | | | Stood 3 days, then 3 hours at 70° R. | |
| Reaction .... | neut. | neut. | neut. | neut. | neut. | neut. | neut. | neut. |
| Polarization.. | 38·1 | 38·0 | ·1 | 39·9 | 37·9 | 38·0 | 37·6 | 37·6 |
| Cane sugar .. | 9·56 | 9·54 | ·02 | 9·51 | 9·51 | 9·54 | 9·44 | 9·44 |
| Invert. sugar.. | ·00 | ·00 | .. | ·02 | ·00 | ·002 | ·038 | ·013 |

Comparing these results we come to the following conclusions:—

1. Cane sugar is gradually changed into glucose by pure water at ordinary temperatures without any noticeable formation of mould.

A diluted solution of cane sugar, heated immediately after its preparation nearly to the boiling point of water for several hours, takes on *no* molecular change.

2. Some salts at ordinary temperatures hinder the formation of glucose, *e.g.*, gypsum, gypsum and chloride of ammonium, nitrate of potash; while others, *e.g.*, sulphate of magnesia, are not able to entirely prevent, but seem to weaken, the action of water.

3. If sugar solutions mixed with certain salts after standing several days at the ordinary temperature be heated to 70° R., ordinarily a proportionately strong change of the sugar into glucose occurs—so also with gypsum, nitrate of potash, and sulphate of magnesia. Water containing gypsum and chloride of ammonium together showed the strongest action upon sugar, and in consequence of the formation of an acid salt, the ammonia volatilizing, the sugar solution showed a weak acid reaction.

4. Sugar solutions mixed with salts, and (*immediately after their preparation*) heated to 70° R., showed a formation of glucose only

in the case of the combination of gypsum with chloride of ammonium; on the contrary, pure water, gypsum, chloride of sodium, and chloride of sodium with gypsum, showed no reaction.

5. The assumption of Bechamp, viz., that some salts, through their "personal" influence, as he calls it, are able without formation of mould to convert cane sugar into glucose, seems to be proved, but by the short action of such solutions it is not possible to give proof of the conversion of the cane sugar with the polarizer, since the errors of observation are greater than the amount of glucose formed.

The presence, therefore, of so small amounts of altered sugar can be affirmed with certainty only by the reduction of Fehling's solution.

6. The action of pure water and salt solutions need not be prolonged more than a few days, since otherwise we cannot count with certainty upon the exclusion of the formation of mould.

7. The preceding experiments seem to contradict the assumption of Bechamp, that cane sugar in pure aqueous solution is changed gradually into grape sugar *only* in consequence of a fermentation produced by fungi. Such solutions probably always contain, before the entrance of the mould, small amounts of glucose, not recognizable by the polarizer.

The change of the cane sugar was apparently not brought about through a true fermentation with evolution of an acid, since all the pure sugar solutions after three days' standing at ordinary temperature [Exp. 1. b. 11. c. 111. b.] were perfectly neutral to the most sensitive litmus paper, and yet showed by the glucose recognizable in them that the change had taken place.

We must therefore ascribe to water in these cases the same part as that played by dilute acids in their action upon cane sugar.

8. Whether the inverted sugar that forms in these decompositions is really $C_{12}H_{12}O_{12}$ cannot be decided off-hand, since besides grape sugar many other carbohydrates have the property of reducing Fehling's alkaline copper solution.

# TRASHING CANE, AND MATTERS PRINCIPALLY CONNECTED THEREWITH.

In *The Queenslander*, of the 24th May, a note appears upon the respective value of trashed and untrashed canes, written by Mr. Strachan, of Loganholme, in which he states that, by a practical test upon each, he proved the latter to yield more sugar, and to be otherwise superior to the former. And again, in issue of the 7th June, a letter appears, signed by Mr. John M'Donald, of St. Helena, giving the results of a precisely similar trial upon two acres of trashed canes and two of untrashed canes. The juices from the former, he states, marked ten degrees Baumé, and yielded more than two tons sugar to the acre; while the juice from the latter marked only seven degrees Baumé, and yielded a little over one ton sugar to the acre. I will now give a short digest of my experience upon it, embracing a period of seventy-five years, and afterwards my views upon the very conflicting reports of these gentlemen, the principal features of which I think I can ostensibly solve.

I was manager of a large sugar estate in Antigua from the year 1798 to 1804, and while living in the West Indies I visited several of the islands. After leaving there, during my travels through the States of North America, I visited the sugar plantations in the district of New Orleans—a climate during winter infinitely inferior to Australia for the growth and full development of the valuable qualities of the sugar cane; the planters there being necessitated to crop cane at the very immature age of nine and ten months' growth, to save them from total destruction by the heavy frosts common in those parts. One ton sugar to the acre is the average yield they obtain; and yet at one time 700,000,000 dollars have been invested upon sugar estates there. These figures are officially authenticated by the Senate of the United States. I thus digress from my subject to prove the immense superiority the Queensland planters have over those of North America, where the cane lands were worth from 200 to 300 dollars per acre.

In 1816, on my way to Calcutta, the ship was bound to touch at

Sydney, and I soon became certain that this country was eminently suitable for the production of sugar; therefore, with the hope of benefiting myself (abortive it has proved), as also of the hollow vanity of being admitted to be a public benefactor by developing this industry, I became a colonist.

Shortly after my arrival, the agent for the London Missionary Society engaged me to establish the sugar industry in the Society Islands (Riatea), where they had suitable works. I so satisfactorily acquitted myself in these duties that, on my return to Sydney, I was presented with a bonus of a year's salary. Subsequently, the Colonial Secretary sent for and offered me the highest salary given to civil officers (£250) to form a sugar plantation at Port Macquarie. This I declined, but accepted the office, on condition that after I had practically proved the eligibility of this climate profitably to mature the cane, my services were to be commensurately rewarded. My first assay there was a model plantation, where I grew a crop of canes which at twenty-six months' growth gave a yield of more than three and a quarter tons to the acre. I was then ordered to form a plantation capable of making 200 tons of sugar annually; was presented with a bonus of £500; was furnished with stores, men, and every appliance to produce the sugar, half of which I was to have free of all charges. I then applied for a mill, motive power, and boilers. In reply, I was told that it was an impossibility for the Government to furnish me with either a mill or motive power, but the boilers would be sent to me. I therefore had to make shift with water power. When the coppers (some 600 gallons) came, to my utter dismay I found them all to be made out of copper, and thinner than domestic kettles. But amidst all the difficulties I made seventy tons sugar, when the coppers broke down. At the same time the settlement was made free, and ultimately the plantation was abandoned, since which time, for more than forty years, amidst the most deadening discouragements and disbelief of my discovery, and an actual outlay of fully £500, I still persevered, well knowing that truth would ultimately carry conviction. Queensland has the credit of being the first colony practically to act upon my long and earnest advice; then after my practically public demonstrations at Kiama of the truthful character of my very voluminous writings upon this matter, this colony followed the example of yours; and so far only, I have the consolation of seeing that my long and earnest labours have proved amply successful.

Now throughout this very lengthened experience, I never either knew, nor have I heard, of the mischievous fallacy of trashing canes, until after 1867 (my public test at Kiama), when a theorist urged the planters to trash their canes, as he said, "cost what it would." As the subject of this letter (trashing canes) is of importance to my friends in Queensland, as also to the planters in this colony, I have been more prolix in expounding it in all its features. Now assuming, which is not invariably the fact, that canes are trashed in the West Indies, such a procedure here would evidently be both injurious and is unnecessarily expensive. During our winter months we have frosts, and a frigid atmosphere which is known to injure the canes by reducing the density of their juices, and impeding their maturity; therefore, ordinary reason points out that by thus prematurely depriving them of their natural protection, we expose them to greater injury by these partially blighting visitations. The leaf of the cane, while green, collects the oxygen in the air and imparts it to the joint, where, with the sap from the roots, the saccharine matter is formed.* When the office of the leaf is effected, it withers and dies, and generally falls off. The joints thus matured are of a healthy appearance; but when the leaves are artificially removed by trashing, they become stained with ugly colours; and if an instrument be used in the act of trashing it cuts out the eyes of the cane, when decay and acidity ensue, and become an injury to the saccharine juices in its immediate vicinity.

Respecting the extraordinary and very conflicting statements made by Mr. M'Donald and Mr. Strachan upon trashing canes, I will first review the former gentleman's letter. He says that he had four acres of canes, two of which were trashed and two untrashed, which, when crushed, the juices from the untrashed marked only seven degrees Beaumé, and their yield of sugar was a little over one ton to the acre; while the juices from the trashed canes marked ten degrees, and their yield was over two tons to the acre. To account for this inferiority of the juices from the untrashed canes, I can account for the causes only by supposing that the untrashed canes had a number of suckers, or luxuriant growing young canes of large size, but with their saccharine matter very weak. This might account for the low density of the average juices. But I am as certain as I am of my existence, that the reported inferiority in their yield, &c., did not originate from their being untrashed. He says: "The bags of sugar from the untrashed canes spoiled the sale of twenty tons." I cannot think it possible that those two tons of damaged sugar infected the eighteen with which they were sent to Sydney; but I have no doubt that if they were all made from canes of the same age as those from which the damaged sugar was, or by imperfect clarifying of the juices, the entire consignment was, as regards its condition, similar to a bag of the sugar made from untrashed canes found in the stores on the island. These facts I will clearly prove by his own words, and other reliable matter to which I shall refer.

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* Chemical Agriculture.

Canes grown near Brisbane, when twelve months old, are no nearer to maturity than those grown within the tropics at nine months' growth. And I may here note a universally admitted fact —namely, that even within the torrid zone canes will not fully elaborate their qualities in less than twelve months. How, therefore, is it possible for them to attain to perfection at that age in this climate, where for three months they are checked in their growth, and partially injured by frosts and a frigid atmosphere?

Mr. M'Donald says: "Canes will not ripen well with the megass on, and if they be not ripe the sugar will not keep." His admission of this well authenticated fact applies equally to trashed and untrashed canes. Now, knowing this fact, and also the important one that the canes from which he made those damaged sugars were not ripe, they, being only ten months old, naturally and of course no further progressed as regards their maturity than those tropically grown of seven months.

I very highly respect Mr. M'Donald as a sugar planter; his energies in seeking for and practically applying improvements in his important vocation are highly creditable to himself and the country he is attached to; but still he, like myself, well knows that he has more to learn, for I do not think there is a planter in the world who is an expert in all the varied requirements of his vocation.

My subject (trashing cane) being financially important to every planter, partly to illustrate my views, I have been constrained to be what some may deem too prolix. But I have yet another fact worthy of their knowledge; it is as follows:—About five years ago, I read the report of an able and scientific examination upon a quantity of decayed sugars in a London warehouse, similar in condition to that described by Mr. M'Donald. It was set forth that the decay and injury was caused by an innumerable mass of microscopic insects, generated from small fragments of cane the juices of which had been imperfectly clarified, and also that the canes had not been ripe. These views were demonstrated by sound and other slightly defective sugars, in the former of which not a particle of megass could be detected by a lens. The opinions as concerning the defective state of the latter named sugars were grounded upon their appearance and their odour, and also by their detecting small quantities of insects in them.

As a sugar planter—most decidedly I do not assume to be an expert, for my experience of his varied duties convinces me that I have still far more to learn. I do assume to have been a truthful writer upon the subject; and, as such, take as my guide only personally and practically acquired facts as they immediately relate to this semi-tropical climate. The history of the industry being based upon its tropical character, is, therefore, almost wholly inapplicable to these colonies. Tropical Queensland is an exception to this remark. As the planters there continue to improve by experience in the skilful conduct of their vocation, the application of recent improvements, and the lights given to them thereon in your journal, I feel assured that they will become as proficient as any of those within the northern tropics. But even now we have all much to learn. The more skilfully their duties are conducted, their expenses will be less, and their profits greater.

THOMAS SCOTT.

*Brisbane Water, N.S.W., June* 23.

## IRRIGATION OF CANE LAND IN PORTO RICO.

The following statistics relate to an irrigated estate, crop 1873. 244 acres plant and 12 acres first ratoons, total 256 acres canes, produced:—

1087 hogsheads sugar and 343 puns. molasses. We ground 21,673,300 lbs. of canes; extraction of mill 62 per cent.

These gave 1,249,995 imperial gallons of juice, taking $17\frac{3}{4}$ lbs. of cane to each gallon, on a series of trials of averaged sized canes it took $3\frac{1}{2}$ canes to each gallon, in some instances one cane gave a gallon of juice.

| | | |
|---|---|---|
| 1087 hogsheads of sugar weighed nett | | 1,451,145 lbs. |
| 343 puncheons of molasses | ,, | 547,266 ,, |
| Total *masse cuite*........ | | 1,998,411 lbs. |

Yielding per acre:—

$37\frac{3}{4}$ tons of cane,
5668 lbs. of dry sugar,
$185\frac{4}{5}$ imperial gallons of molasses.

To make a hogshead of sugar we ground 19,938 lbs. of cane, or on an average about 4000 canes to each hogshead, these gave $1150\frac{87}{100}$ imperial gallons of juice weighing 12,361 lbs.

The hogsheads averaged 1335 lbs. nett.
The molasses from each hogshead $503\frac{46}{100}$ lbs.

| | |
|---|---|
| Each gallon juice produced | 1·16 lbs. dry sugar. |
| | ·43 lbs. molasses. |
| Total green sugar per gallon | 1·59 lbs. |

1493 lbs. of cane produced 100 lbs. dry sugar, and the proportion of molasses to this was 37 lbs.

100 lbs. juice gave 10·79 per cent. sugar.
4·07 „ molasses.
14·86 *masse cuite.*

100 lbs. canes gave 6·74 per cent. sugar.
2·54 „ molasses.
9·28 *masse cuite.*

The sugar was sold here and averaged throughout the crop 4 dols. the 100 lbs.

The molasses 30 dols. the 110 gallons "wine measure." We sell molasses by wine measure, but otherwise these calculations are based on the imperial gallon.

Each 100 lbs. of canes producing :—

| | |
|---|---|
| 6·74 of sugar gave in cents.......... | 26·96 |
| 2·54 of molasses „ .......... | 6·02 |
| Total gross product in cents.... | 32·98 |

The cost of cutting and carting the canes, manufacture, interest on value of machinery, &c., interest at 10 per cent. for wear and tear, incidental expenses attending manufacture, hogsheads cartage, &c., were 13 dols. 26 c. per hogshead, or cents 6·65 for each 100 lbs. canes, leaving $26\frac{33}{100}$ cents. for cultivation and profit.

To produce this result the lands had been ploughed three times, then furrowed at six feet from the centre of furrow, and the subsoil plough passed up and down each furrow to loosen the soil, and at every five feet in the furrow one cane plant about six inches long was inserted in a hole made with a crowbar. Most of the cane pieces had five weedings, and on some of the inferior lands a small quantity of rotten salt fish and herrings was given to each cane stool: the canes were always well irrigated. Cultivation costs about 40 to 45 dols. the acre: in dry districts we expend less in weeding, but this is counterbalanced by that of irrigation.

We had three men constantly employed in irrigating these 256 acres, but at the same time they irrigated an equal extent of land in canes for crop 1874. It requires experience and careful labourers to irrigate properly, so as to avoid washing the lands, which might do permanent damage, or allow the water to stagnate in the trenches, which is apt to rot the roots of the larger canes, and might seriously check the growth of the smaller ones.

Last year we had a very dry season, estates on the south coast that had no irrigation produced little or nothing, whilst those well irrigated gave results similar to the one here stated.

Our mode of irrigation is very simple. We bring the water from the spring, or brook or river, as the case may be, to the highest point of land possible in the cultivation. This is done in a similar manner to that used in the Windward Islands, to bring the water to their mills. Our cane pieces are generally long and narrow, any length; and one acre, or at most one and a half acre wide. I generally put them one and a quarter. Round each piece we make a trench, if possible, three spades deep and from two to two and a half feet wide. At every six, eight, or ten rows, according to the nature of the soil, we make a small trench across the piece and parallel with the canes rows. These trenches are generally made from sixteen to eighteen inches wide, and two spades deep, being one spade less than the side trenches—consequently, when these are open the cross trenches remain dry. This is very necessary for irrigating effectively; also in any low spot, where water might stagnate we make small cross trenches. The great object in irrigating properly is to wet the soil thoroughly without swamping it, and to drain it effectively afterwards; the water should be kept moving, and never by any chance allow it to remain in the trenches till it forms moss. Water may be dammed up in the trenches at any hour of the day, but should be drawn off in the evening, so that the soil may drain during the night, it is then cool and suffers less from the effects of the next day's sun, in young canes this should be carefully attended to otherwise injury may be done, and the growth of the young canes checked. Where water is abundant canes should be irrigated frequently, never less than once a fortnight; and on light soils when once the canes cover the ground it is difficult to give too much water; but two or three weeks previous to cutting the canes no water should be put on the land, otherwise the juice will be deficient in sweets and the cane stools will be injured by the carts passing over them.

The mode of damming up the water in the trenches is very simple, a piece of bamboo or stick of any kind laid across the trench, a few others placed in a slanting direction facing the coming water, a few bundles or handfulls of cane trash or grass from the ranges, and over this some earth taken from the bottom of the trench, and well plastered so as to prevent the water percolating; using heavier wood, a very large trench may be effectually dammed up in this way in a very short time; the greater the quantity of water in the trench, the more slanting should be put the sticks to support the trash and dirt. An upright dam does not hold water well.

By these dams the water is forced into the smaller trenches, and in these it may be necessary to place small dams, so as to keep the water about an inch or two below the surface, as a rule water should not be kept more than 48 hours on a piece of land; but this, of course, depends greatly on the nature of the soil.

The most difficult lands to irrigate judiciously are heavy saltish land, such as we have in the low lands of Ponce; in these there is very little filtration, and in time the salt floats up to the surface and injures the plants. On these lands irrigation should be frequent and quick; after each irrigation they should be drained thoroughly, and before damming up the trenches for another irrigation fresh water should be allowed to run freely through the trenches, so as to wash out the deposit of salt, otherwise the salt so deposited is sure to soak back into the soil. By judicious irrigation and opening the trenches whenever it rains, so that the salt may wash out, these kind of lands may be easily and effectually improved.

Richard E. Burton.

## PROPORTION OF WOODY FIBRE IN CANES GROWN IN THE EAST.

The following are the results of the experiments I made to find the yield obtained from the canes on four Estates in the East.

### No. 1 Estate.

This Estate is the finest of the group, the soil being a low lying, rich alluvial deposit, reduced by liberal cultivation to a free porous loam. The district is exceptionally favoured with rain, the fall ranging from 70in. to 80in. per annum. The canes mature in 12 or 13 months, but owing to the humidity of the climate, are generally cut somewhat green. The canes are never ratooned, and the land is replanted as soon as possible after cutting. The average yield on vacuum pan, centrifugaled, and run dried sugar over 11 years has been 26·41 cwts. per acre.

*Woody Fibre.*

Description.

| | | | | |
|---|---|---|---|---|
| Fine Mauritius cane .. .. .. | 1⅞in. diar. | full | 10·07 | per cent. |
| ,, Chinese or Salangore .. | 1¾in. ,, | | 10·747 | ,, ,, |
| ,, Ribbon .. .. .. .. | 1½in. ,, | full | 11·634 | ,, ,, |
| ,, Black Java .. .. .. | 1⅛in. ,, | full | 12·84 | ,, ,, |
| | | | 45·291 | |
| Average of fine canes .. .. .. .. | | | 11·322 | |
| Average Mauritius cane .. .. | 1¼in. diar. | full | 10·869 | per cent. |
| ,, Salangore ,, .. .. | 1⅛in. ,, | full | 11·527 | ,, ,, |
| ,, Ribbon .. .. .. | 1⅜in. ,, | | 11·538 | ,, ,, |
| ,, Black Java .. .. .. | 1 1/16in. ,, | full | 12·301 | ,, ,, |
| | | | 46·235 | |
| Average of Average canes .. .. .. | | | 11·558 | |
| Average of the above experiments .. .. | | | 11·44 | |

The mill is 70in. × 32in. in good working order.

Calculating woody fibre as above, the following results were obtained.

| | | | |
|---|---|---|---|
| From well squeezed sample of megass,—Juice | 70·87 | per | cent. |
| Average ,, ,, ,, ,, ,, | 69·023 | ,, | ,, |
| | 139·893 | ,, | ,, |
| Average yield from the cane .. .. .. | 69·946 | ,, | ,, |

### No. 2 Estate.

This Estate is similar in character to No. 1, but the soil is not so rich. Average yield over five years 23·73 cwts. per acre.

*Woody Fibre.*

Two samples of Mauritius cane gave an average of 14·976 per cent.

The mill is 60in. × 30in., and in excellent working order.

Calculating woody fibre as above, viz.: 14,976, three experiments showed an average yield from the cane of 68·2 per cent. of juice.

A direct experiment with the same mill on about 2½ cwts. of cane showed a yield of 67·01 per cent. of juice.

### No. 3 Estate.

The soil of this Estate is much higher and somewhat poorer than the preceding. The average yield over 12 years has been 18·15 cwts. per acre, but the lower yield on this Estate is principally due to the machinery having been very inferior.

*Woody Fibre.*

| | | | |
|---|---|---|---|
| Fine Mauritius cane .. .. .. .. .. .. | 15·57 | per | cent. |
| Average ,, ,, .. .. .. .. .. .. | 16·97 | ,, | ,, |
| Poor ,, ,, .. .. .. .. .. .. | 18·11 | ,, | ,, |
| | 50·65 | ,, | ,, |
| Average of three experiments .. .. .. | 16·88 | ,, | ,, |

The mill is 45in. × 24in., and in bad working order.

Calculating woody fibre as above, viz.: 16·88, three experiments showed an average yield of—

58·42 per cent. of the cane.

A direct experiment with the same mill on about 4 cwts. cane gave a yield of—

54·42 per cent. of juice, but the feeding not having been well managed and the megass being below the average work of the mill, it was repassed with the following result:—

| | |
|---|---|
| First passing .. .. | 54·42 per cent. of juice. |
| Second ,, .. .. | 11·32 ,, ,, of ,, |
| Total .. | 65·74 .. .. of juice. |

## No. 4 Estate.

The mill is 60in. × 28in. in average working order, and two direct experiments on about 6 cwts. of cane gave the following results:—

| | |
|---|---|
| No. 1 .. .. .. | 64·71 per cent. of juice. |
| No. 2 .. .. .. | 64·45 ,, ,, ,, ,, |
| | 129·16 |
| Average .. .. .. | 64·58 per cent. of juice. |

After all, the woody fibre experiments come much nearer those I made in the West Indies than I supposed. I can only account for the difference between No. 1 and the others by the fact that the canes on this Estate yield much better.

H. O. Bennett.

# SUGAR MACHINERY.

From "*Iron.*"

The assessment of the relative values, and precise position in the scale of importance, of the many different industries that nowadays minister to the necessities and luxuries of mankind, is a difficult, it may be a profitless, task; but be this as it may, we cannot be far wrong in asserting that, however otherwise the order of classification may be varied, the industrial applications of machinery to the production of food and raiment must claim precedence of all others; and, inasmuch of these two human needs the one is, and the other is not, absolutely essential to existence under all circumstances, it is a fair conclusion that food-processes are at least the most important and necessary, if not the most extensive and complicated, of the industrial applications of machinery. And even in food processes there are distinctions to be drawn; for although, to use a trite saying, bread is the very staff of life — and as the old dame observed, "pudding is a very good crutch," sublimely unconscious that the two are merely the same thing under different culinary externals — yet in its production and manufacture mechanical aids and appliances do not, and need not, count for much. And although sugar itself, regarded strictly, is not an essential, but only a luxury of food, yet it would, we think, be difficult to find any other food-product that can rival sugar in importance, as the object and result of purely mechanical aids to merely human powers.

One word of reservation here. Without wishing unduly to exalt the science of Mechanics over that of Chemistry, we must, from our own standpoint, give the preference to the mechanical over the chemical side of the consideration of the various processes involved in the manufacture and production of sugar; because while far from ignoring the abstruse and complicated nature of the actions and reactions involved, we regard these as matters affecting the analytical rather than the practical phases of the question.

It is very easy, we may say customary, to ignore and underrate the real value and importance of sugar as an alimentary element under our somewhat artificial civilisation — still more easy and prevalent is an entire ignorance of the important part played by machinery and mechanical appliances in its manufacture; and yet the engineering industrial interests associated therewith are really great, and of almost primary importance, of which indeed there can be few more striking examples than the subject of the present article, the Bloomsgrove Works of Messrs. Manlove, Alliott, and Co., of Nottingham and Rouen, a firm whose extensive energies and resources are almost entirely devoted to the production of sugar machinery.

The question of the natural sources whence sugar is obtained is far from being independent of the mechanical processes associated with and essential to its successful and profitable manufacture; and we therefore make no excuse for the apparent digression of a brief *résumé* of sugar as a natural product.

Though sugar be nowadays a common substance, in every day use, two averments may confidently be made thereanent, namely, that there is an equally common ignorance of the physical and chemical nature of the processes involved in its manufacture, and that sugar itself was almost as much unknown to the ancients as the "sugar duties." Pliny, who has always been esteemed the highest authority on matters of natural history and science in the classic times antecedent to the era of strictly modern discovery, makes mention of sugar, it is true; but the knowledge thereof which we derive from his writings is limited to the statement that it is like salt, and only of use in medicine. Something very similar is the *pronunciamiento* of another learned antique, Dioscorides; so that neither the Greek nor Latin races of that day could lay claim to any exactitude of knowledge upon the subject. If we consult the pages of Arian, Theophrastus, and Strabo, thereupon, we find it spoken of as a species of honey, produced from a reed growing in the countries of India and Arabia; which, it must be confessed, is a nearer approximation to the truth, and indicates that their knowledge was then limited to the crude product of the sugar-cane, the sap or juice. In classical times, however, honey—*e.g.*, the honey of Hymettus—would seem to have been the only sweetening substance generally known or employed: we find it mentioned in the pages of Homer, as employed for sweetening wine, and from the writings of a later period it would seem to have occupied the place now fulfilled by sugar in connection with cookery and comestibles. The statement of Pliny, as to the resemblance between sugar and salt, appears rather to indicate a physical similarity, whence we may infer the knowledge of sugar in a crystallized, or partially crystallized condition; but, inasmuch as old honey naturally assumes a dry and crystalline condition, it may not unfairly be assumed that the crystalline state of the juice of the sugar-cane, if then known, was rather the result of simple natural causes, such as

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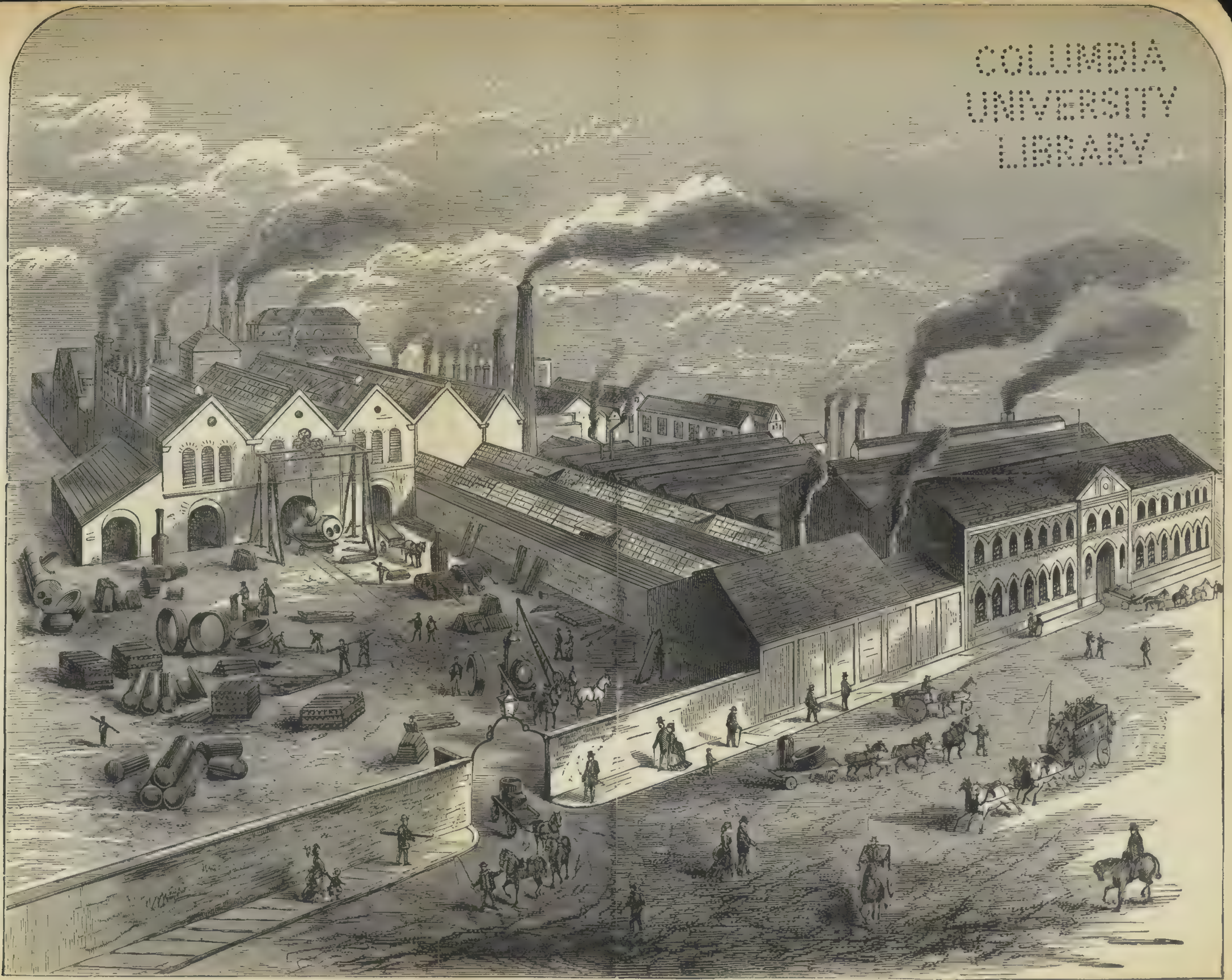

MESSRS. MANLOVE, ALLIOTT & CO.'S BLOOMSGROVE WORKS, NOTTINGHAM.

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evaporation, than of any process of mechanical treatment; and it is even probable that, as in the present case of the natural gums and sap of trees, mere exudation after the cutting of the cane, was the only means by which the sugar juice was then obtained; and that no mechanical process of comminution, or cutting was resorted to for the purpose of increasing the yield; whereas now, the thorough crushing of the cane by heavy rollers, and the extraction of the greatest quantity of juice by extreme compression is the modern basis of economical and profitable treatment.

Amid all the vagueness of early tradition, it seems clear that the knowledge, cultivation, and treatment of the sugar-cane and its valuable food-product have, like many other good things, journeyed from east to west: of Saracenic origin, brought into Western notice in the time of the Crusades, the islands of the Mediterranean were the first European sites where its culture was introduced, as in Cyprus, Rhodes, Crete, Sicily; whence, travelling ever with the sun, it founds its way through the Pillars of Hercules to Madeira, and was thence, somewhat less than four centuries ago, transplanted to the central American Archipelago. Here the newly imported plant flourished, and became naturalised, and its culture has attained such a magnitude of growth and importance, that the West Indies have become the chief source of the supply of sugar for the worlds Old and New. But it has, we may say, been reserved for the mechanical genius of the nineteenth century to bring the manufacture of sugar to the utmost degree of perfection and economy, such as it has now attained. Sugar at 2½d. per lb., as it is now coming to be quoted, would seem to represent an inferior limit of cheapened production beyond all previous precedent.

In this connection, however, our remarks upon the present subject are purposely limited to the preparation of cane-sugar, in reference to which the illustrations which have more particularly been prepared to accompany this account of the industrial works of Messrs. Manlove, Alliott, and Co. have more especial relation, this being the oldest process. We shall therefore limit ourselves to a brief preliminary reference to the other members of the vegetable world from which sugar is or may be extracted; and of which one, at least, constitutes the basis of a very important branch of industry on the Continent, and to a very minor degree also in England and Ireland. The existence of sugar in the sap of the birch and maple trees, and in the vegetables parsnips, carrot, and beet, had been pretty generally known before any attempt to utilise the same on any commercial scale of manufacture was instituted in rivalry of cane-sugar; and it is quite within this century that the manufacture of sugar from beet has grown into importance in France, under the inciting and fostering influence of that spirit of hostility that unfortunately marked the opening decades of the nineteenth century. In this country, at least, the beet-root sugar industry has taken but feeble root, and failed to attain any vigorous growth; while the original source of sugar, the sugar-cane, has of late years more than held its ground; which may be regarded as mainly, if not entirely, due to the degree of perfection attained in the mechanical applications associated with its treatment: and of such machinery in its most improved condition, and of the constructive, engineering, and industrial resources engaged in their development and production, an excellent illustrative example is furnished by the subject of this article, Messrs. Manlove, Alliott, and Co., a firm long connected with the business, and who not only carry on large works at Bloomsgrove, near Nottingham—of which we give herewith an engraving showing a general view—but also a branch establishment at Rue d'Elbœuf, Rouen, in France.

The other engravings which serve as illustrations of the industrial operations of this well-known firm are as follows, namely: a general plan showing the arrangement of a sugar factory on a large scale, as laid out and fited up with the most modern and improved machinery and appliances; a plan and elevation of the chief machinery employed, viz., the "sugar mill" proper, and prime-motor actuating the same: and various details of Fryer's Patent Concretor, one of the most recent and efficient inventions connected with the process of manufacturing sugar.

*(To be continued.)*

# ON BEET-ROOT AND BEET-ROOT SUGAR.

*(From a Pamphlet by E. F. Cull, of The Canada Company, Toronto.)*

*(Continued from page 517.)*

Cane sugar, even when made at the best season, in the best manner, and from the most favourable growth of cane, contains a large proportion of molasses and uncrystallizable sugar which will not, and does not in its native state, crystallize. The after processes of the refiner, however, finally extract all that portion which will crystallize from that which will not, and the latter is disposed of as treacle, or as the various grades of golden and other syrups.

It is quite true that a considerable portion of the sugar from the sugar cane is used as a domestic sweet in the shape of brown sugar, but even this has been partially refined; but by far the greatest quantity of sugar used is refined in the great English and American refineries before it reaches the public.

Canadian ideas of the manufacture of sugar are formed from the maple sugar made on the farm. This is the purest source of sugar which the vegetable kingdom supplies. It has deposited all its woody portions and impurities in the tree, the growth of which it nourishes, and we get it filtered and purified to the greatest possible extent.

Beet sugar must not be looked at for a moment with the same ideas, or treated in the same manner.

The beet root contains, besides sugar and woody matter, portions of albumen, pectine, and other substances, and also a flavouring matter of a strong beety odour, but chiefly large quantities of potash and salt.

Were it not for the potash and salt, and the strong beety flavour before spoken of, the juice of the beet when defecated would boil down into a pure crystallizable sugar, at once usable as maple sugar is.

It is the beety flavour and the potash and salt which we have difficulty in getting rid of. These matters, however, yield at once to the operations of the refiner. The only portions of the extract from the beet root which in the refiner's hands are not made use of is the essential oil which causes the strong flavour, and any other impurities which ought to have been removed before it came to his hands. The mixture of potash and salt, when extracted from the syrup and purified, is really worth weight for weight, at least as much as the sugar.

Where people wish to engage in the manufacture of alcohol from the beet root, they can do so to a great profit, as beet root yields to the distiller far more spirit per acre than the best crop of either grain or corn. The apparatus for distillation is quite simple, and comparatively inexpensive.

The following table will show the money value obtained from the entire beet root crop in France *alone*, in the year 1865-6; and it must be remembered that Germany, Belgium, Holland, Austria, and Russia, all make their own sugar, or at all events the greater portion of it, from the beet root, and in all cases it must also be remembered that the beet root industry is one that has been, and is, constantly increasing.

The beet harvest of 1865-6 in France alone, produced

| | |
|---|---|
| 275,000 tons of raw sugar, worth - - - | £6,250,000 |
| 100,000 pipes of strong spirit, each pipe containing from 100 to 120 gallons, part distilled from the root direct, without the assistance of the sugar manufacturer, and partly from the molasses, and worth - - - | 1,350,000 |
| 20,000 tons of potash, worth - - - - | 500,000 |
| 1,600,000 tons of pulp, worth - - - - - | 1,000,000 |
| | £9,100,000 |

This is what is produced from the entire beet crop—not the value of the produce of the sugar manufactory.

The imports of beet root sugar at the British and Scotch ports for the first eleven months of 1871, were 134,480 tons, against 56,670 tons for the same period in 1870, and 31,060 for the same period in 1869; this shows the enormous increase of the manufacture.

Now, it is perfectly ridiculous to suppose (in the face of such a statement as the foregoing) that Canadians and the inhabitants of America generally, are going to confess inferiority to the French and Germans, and to allow it to be said, we have not nationally sufficient intelligence to make sugar from beets, when the continental nations are able to assist in supplying the world with that necessity.

Some people have been rash enough to say that our climate and soil are not fitted to produce the root rich enough in sugar to pay. This we most emphatically deny. The extended trials of the American patent office, and the numerous instances of Canadian grown beets which have during the last two years come under the writer's hands, all show beyond question that Canadian beets, where well selected and well grown, are as rich in sugar as the best French and German or continental beets. If any one doubts it, all he has to do is to grow a patch of the best kinds of sugar beet in his field or garden, and following the instructions hereafter given, reduce the roots to such a state that the amount of refined sugar they contain is easily proved by the ordinary tables and instruments. Others will say, and they are far the most practical, If it can be done, why has it not been done? In reply, I affirm that it is only because the manufacture has been made a mystery of and has not been understood. The chief trouble of the manufacture has consisted in the uncrystallizable sugar, and this, it is now proved beyond a doubt, has been caused not by the sugar contained in the well grown root being inferior, but by the process adopted being imperfect. If the following instructions are carefully carried out, all difficulties and troubles as to uncrystallizable sugar will cease to be a serious obstacle.

With these few observations, I propose to lay before the readers of this little treatise, full instructions for the growth of the sugar beet, and its conversion into such a class of crude sugar as is best fitted for the refiner, and in every way equal for the purposes of refining to the best tropical sugar that is produced.

### SUMMARY OF THE PROCESS.

I shall first describe in very few words what is necessary to do, and then more at length the best way to do it.

The roots are washed with great care after being stripped of the leaves, and the crown being cut off, taking care not to break off the small lower end of the roots, which are richest in sugar.

The roots are then rasped down into the finest possible pulp.

The pulp is then pressed so as to get out the juice in the most perfect manner, and clear from all particles of root.

The juice is then put in the boiler and brought to a boiling heat.

As soon as the juice boils, you add to it milk of lime, carefully made from fresh burned lime-stone. The way to make milk of lime will be described further on.

The addition of the milk of lime checks the boiling, and you will see the juice turn from its black disagreeable colour to a light shade, at the same time it breaks into flocks, a kind of curdling taking place. You stir the juice just enough to mix the milk of lime all through it, but not enough to break up the flocks or curdlings.

As soon as you see that the juice clears between the flocks (which will be in the course of a minute or two), the whole contents of the boiler are, as rapidly as possible, cast on to a filter cloth of canvas; as fast as it strains through the canvas it must be pumped back on it until the juice runs through the canvas bright and clear as wine. It should be of the colour of pale sherry.

When you find it run clear let it go into a shallow vessel, and cool as quickly as possible.

When the liquor has cooled down to 120° Fahrenheit, set the carbonatation bellows (hereafter described) to work, and continue to pump or blow the carbonic acid fumes from charcoal, or hard anthracite coal, through the liquor. This gas destroys the causticity of the lime, and makes it into a carbonate, and it then falls down in the liquor like a fine mud.

You continue to blow the gas from the carbonatation bellows through the liquor until all caustic in the lime is destroyed. This is known by the thick mud settling rapidly out of the liquor, leaving it clear and fine.

Then take some of the clearest in a glass, or, if you can do so, filter a little through a close cloth, until it is fine, then blow with a pipe or straw your breath from the lungs through the liquor. If your breath muddies the liquor, the bellows have not worked long enough. If your breath does not muddy the liquor, the carbonation is complete.

Then filter the whole through canvas until it is quite bright and as fine as wine, returning the first runnings until it runs clear. It will be quite bright, and may be a little darker than it was before it was carbonated.

It is now fit to evaporate down into syrup; and as soon as it reaches the proper density, or proof, it is set by in a warm place, and in the course of eight or ten days the whole mass will crystallize into coarse dark crude sugary substance, and this then, as soon as it is parted from what little molasses it contains, is fit for the refiner.

Had the syrup been evaporated in a vaccuum pan (as it ought to be when the operator can afford it), the crystals of sugar instead of being brown will be nearly white, and only require the cleansing action of jets of steam in the turbines, which will be described further on.

As soon as the crude sugar is all crystallized, throw the mass into the turbine, which is then made to revolve rapidly, and the molasses are thrown off through the wire gauge, or perforated sides, of which the turbine is composed.

The resulting sugar, although not fit for domestic use, is then fit for the refiner, and is at once a saleable article.

The molasses are set by to crystallize again, after having been exposed to the osmose process, which is described further on. Where the crystallization is very complete, it may be a question whether it is not better worth while to feed the molasses to the pigs and cattle than to purify it; but it must be fed in very small quantities. By doing so the farmer gets the full benefit of all the salt and potash in his manure, which is a most important thing to do. In small quantities it is very wholesome and fattening to the cattle.

The only drawback to growing beets on a farm for sugar making, and that is more a theoretical loss than a practical one, is the loss of the potash and salts which go off in the molasses; but they are retained by being fed to the cattle and hogs; and if this course be pursued, the beet farm would in a very short time attain such a pitch of fertility as to render exhaustive crops now and then an absolute necessity.

With these plain instructions before them, those who cannot make a crude merchantable article of beet root sugar are certainly not fit to conduct any business or farming operations on anything but the most limited and consequently unprofitable scale.

Where, instead of making sugar from the beets, spirit is distilled, and the slop or refuse and the pressed cake from the roots are used on the farm, beets may be grown in the same land year after year with an annually increasing productiveness. This has lately been proved in England (and long since was proved in France and Germany). In England beets which are used for distilling have been grown on the same land for seven years following with the best effect, the manure from the former crop being used, and the crop in the later years more than doubled; while from the continuance of hoed crops the weeds have been all but exterminated. What a prospect this holds out for our Canadian thistle infected lands.

The same effects would follow in making sugar from the beet provided the molasses were fed to the stock.

In all the departments in France and in Germany where beet sugar is grown and manufactured, the yield of wheat produced in those departments has been more than doubled, and that notwithstanding that potash and soda is made from the refuse of the sugar and sold and taken away from the land, thus really depriving the land of important mineral constituents—so fertilizing to the farms is found the feeding of the beet root pulp and the increase of manure from the numbers of cattle kept on it, in spite of the loss of potash and salts in the sugar crop.

We will now go more closely into particulars and begin with the

### CULTIVATION OF THE ROOTS.

The proper cultivation of the roots is one of the great requisites to ensure success in the manufacture of beet sugar. The culture and planting should be such as to ensure roots of small size, not exceeding three to four pounds each, and often under this standard. The crop will be equally or more productive in sugar, if the major part of the roots are grown so thick, in the row, as to ensure their small size. The after management, must also cause the root to be almost or altogether under the earth; as, if otherwise grown, that part exposed to the light, will not yield a full supply of sugar; and it has been the received opinion of many analysts that glucose instead of crystallizable sugar is thus formed. The seed should be sown in drills about eighteen inches from centre to centre, and the roots may stand at six inches apart in the row. Of course they will be thicker at first, but may be thinned to that distance. The land should, and must be pulverized and prepared so that when burying the seed there may be about one and half inches of fine mould to fill in over it. At all events the depth of the seed must not exceed two inches, when covered in; and above all a moist time should not be neglected to complete the sowing. The seed to be sown may be either the Vilmorin or white Silesian; both are good, but ordinary unnamed sugar beet must be avoided, as it too often is only white mangold wurtzel. The preparation of the soil is most important; in fact, it is imperative that to ensure ease of culture and certainty of crop, one course should be pursued. As to soil, any quality of good dry land will answer well, and any previous crop will not materially affect the following beet yield. But it is absolutely requisite that the following course be followed. We will suppose the land that is to be sown with beets has been summer fallowed—If this course is pursued it will amply repay the time lost, and expense incurred by doing so: but fallowing, although advisable, is not absolutely necessary. About the beginning or end of September haul out the manure—any kind will do, but some is very desirable—spread a thin coating over the field, then ridge and furrow the land, throwing one furrow each way; exactly the same as if you were hilling up potatoes. The manure will then all be directly under the ridges so formed. Nothing more need now be done to the land before the middle of April, by that time the seeds commence to sprout, and tiny small, plants can been seen. You must now construct a harrow, or succession of very small light double harrows, so small that each will take a ridge; there must be a joint in the centre to allow each wing to travel on one side of each row. All the weeds will be killed by this harrow, and the rows will not be lowered more than one half the original height. Once each week the land must be harrowed until the middle of May—when all the weed seeds within the influence of the air will have germinated, and the land be absolutely clean. Now sow the seed, and two weeks or less will see all the plants up in rows, and no weeds to injure the growth. There you see you have expended very little labour on the land, only once ploughing, and this is all to be done in the fall; your land is clean, fine, and free from weeds; the beets will then get the start of any that may subsequently grow. Directly you can do so with safety to the young plants, run the horse scuffler between each row. This implement must be so constructed as not to do too much. The weeds will be small and easily destroyed. A slight hoeing in the row may be necessary, but if the land was fallowed the year previously, there will hardly be any occasion for it. But if the land be not fallowed, the same system must be pursued. The same fall manuring, the same ridging up, and the same harrowing in the spring. Whereas if an opposite course be followed, and the work all done in the spring, the weeds will have a fair even race with the beets. The land will have laid dead and wet all winter without any early spring drying and exposure to the air by the furrowing system. And in many cases there will be a fortnight's difference in the time at which the seeds can be sown. It will readily be seen that all the manure will be *under* the ridge, and nearly double quantity of surface soil will be *in* the ridge, and there will be so much more depth of earth for the plant to penetrate, instead of being forced out of it, there being no doubt that every pound of root grown at the bottom, deeply buried in the earth is worth one and a half pounds of that portion exposed to the air and light. Hence the necessity for earthing up; and this must be done occasionally with a double mould-board plough, so set or constructed that a little fine earth can be raised from between the rows and deposited nicely on each side of the plant, leaving however, a small ridge out of which the green may grow. The rains will wash these small ridges down somewhat. When in England, some years since, the writer used a plough for a number of seasons, with excellent effect.

About the last of September the roots will be ripened sufficiently to commence grinding and pressing, and we now come to the most troublesome part of the process so far as cultivation of the root is concerned. Hitherto every thing has depended (so far as trouble of manipulation is concerned), on suppressing the growth of weeds until the beet plant shall have sufficient power to overgrow them, and if the foregoing directions be carefully followed there will be but little trouble or expense. The preparation, manuring the land in the fall cannot be too strongly enforced. By so doing you have the manure all well decayed just when the plant requires it; you have a double depth of earth for its growth over the ordinary level field; you have the land dry and wholesome for spring harrowing; you have above all things the start of the weeds, and ever afterwards during that year the beets will be ahead in the race instead of being at times overrun and half smothered, and during the summer you have a depression into which all weeds will naturally be swept by the action of hoeing, which thereby escape all chance of rerooting after rain, in the row, and you have an easy mode of cultivating during the summer with a properly constructed scuffler, between the rows as occasion requires.

### WASHING THE ROOTS.

The roots before being submitted to the rasp, must be thoroughly washed in a rolling cage, great pains must be taken that no dirt shall be allowed to remain on the roots when they come to the rasp, and the heads of the roots and leaf stems must be carefully cut off; and if cattle are kept to consume the portions of the root which come from the press, so that waste would not occur, the whole head of the root ought to be cut off, and fed to the cattle. It has been proved time and again that the extremity of the root end of the plant is the richest in sugar, whilst the portion which is grown above the ground is the part which contains the largest proportion of potash and salt. Hence in the continental countries of Europe where the government excise duty is charged on the roots consumed; the entire portion of the root which grows above the ground is cut off and rejected for sugar purposes. Any plan which will ensure perfect cleanliness in the roots, is that best adapted to the work, and the roots should be allowed to drain off all superfluous water, before they come to the rasp.

### RASPING THE ROOTS.

The roots should be presented to the rasp endwise, and the rasp (however constructed), should reduce the root to the finest possible pulp. The pulp, should then be passed through rollers working together, which are of sufficient surface to receive and crush the pulp as it comes from the rasp. The rollers will thus reduce the pulp to a perfect smooth paste, and burst all the cells of which the root is formed, and which cells contain the sugar.

There are many ways of making the rasp. That is the best which works with the greatest speed, and reduces the root to the smoothest and most complete pulp.

### PRESSING THE PULP.

The following is the old fashioned plan. There have been, and will be many improvements. The pulp must be placed by small parcels at a time (according to the size and power of the press), on strong canvas cloths, each cloth being laid over a frame about two inches deep, and the size that will go into the press; the cloths must be much larger than the frames. When the frame is full, fold over the cloth first from side to side, then the ends over; then place the cushion of pulp so formed in the press; there must be a strong board larger than the cushion of pulp, and it must rest on one board while another covers it; one board going one way of the grain, the next above crossing it, and so on, parcels of pulp and boards until you have the press full. Then put on the power gradually, so that the juice can escape readily from the cloths, without bursting them; press to the full power of the screw, and take care to catch all the juice.

The juice should run from the press at once into the kettles, where the heat should be raised as quickly as possible to 150° Farhenheit's thermometer, and it should not fall below this heat, so long as the kettle is filling.

When all the juice is out that you can get out at the first operation with the press, take the cakes of pulp, put them in hot water, and let them soak for an hour. The water must be nearly boiling, as the cakes will cool it sufficiently. When broken up and mixed with the hot water, which they should be at once, the heat ought to be between 150° and 155° (Faht.), and if not so, add more hot water until that heat is attained; then cover up, and keep it all hot. This is necessary, to prevent fermentation or acetification. Then proceed to press the mashed roots again, in the same manner as at first.

It is scarcely worth while to squeeze the pulp more than twice, although it ordinarily takes three pressings to get out all the sugar. If your press is sufficiently powerful you can get out all the juice at once.

Strain the juice through a fine strainer, and get the juice into the kettles as soon as possible. Neither the first juice nor the second must ever be allowed to fall in heat below 150°, or souring may commence. When in the kettles, heat the juice as quickly as possible, to just boiling; then add the lime in the following manner; the juice will be very black, and dirty looking, but it will all come right with the lime.

### TO MAKE THE MILK OF LIME.

Get some good, new, hot lime, slack it in boiling water; stir it up, and let it settle for a minute or two, and pour the liquor off the dregs. You must leave all the coarse part of the lime behind; only take off the *milk* of lime, which must be quite smooth and without grit.

This should be made and put in a barrel; the lime must be caustic and strong; when kept under water it will keep for any reasonable time in a caustic state. When the juice boils, add some of the milk of lime to it, and stir it slowly. When you find the juice change colour and curdle, showing clear in spots, and when it shows signs of settling, you have put lime enough; stir the juice gently until the lime is mixed well through it, but don't urge the juice to a rapid boil; then take out a sample in a glass and see if it clears, and is the colour of white wine; if so, enough lime has been put, if not, put a *little* more, but don't put more lime than enough. As soon as the juice flakes, or curdles, it is done. It need not be more than five minutes from the time you put the lime until you filter the juice.

Now empty the juice as quickly as possible out into a canvas strainer, formed by stretching a canvas cloth so that it hangs down in the middle; it should spread as wide as possible, so as to give the greatest amount of filtering surface. As long as the juice runs thick, you must pump back again on the filter, taking care that it shall enter the juice in the filter, with as little disturbance as possible. When the juice runs clear, let it drain through the filter cloth without further disturbance. It should be as clear and bright as any wine; it is then right.

Let the strained juice get cold, and it will then be ready for carbonatation.

Although the juice is now so fine and clear, yet there is a great deal of lime in it, though you cannot see it, and this lime is caustic. This causticity must be destroyed, and the lime turned into its original chalk or lime stone, though in a state of fine mud; and this is called carbonatation.

### CARBONATATION.

To effect this operation you must get a pair of blacksmith's bellows, or any other good blowing machine, and have a pipe fixed to the nozzle, which is to go down into the juice; the pipe should be long enough to curl round the bottom of the vessel which contains the juice, and it must be pierced full of small holes, so that when the bellows are worked, the air they contain will be forced in numerous small streams through the liquor. But the air alone will not carbonate the lime, so you must make the following arrangement. Get a number of lengths of common stove pipe, to a length of from ten to fifteen feet. At one end is fixed a charcoal stove, with the means of closing the top, so as to enable you to draw the air as much as possible through the charcoal fire; fill the stove and light it; as soon as the coal burns clear from smoke, it will be ready to use. The object of the length of the stove pipe, is to disperse and let the heat pass off, so that you may not burn the bellows.

*(To be continued.)*

## ANALYSIS OF CRUDE SUGARS AND SYRUPS.

By H. Landolt.

*Translated by J. M. Merrick, B.Sc.*

(Continued from page 552.)

*The conclusion may be drawn from these researches that the exactness which can generally be reached in optical sugar determinations, with reference to different observers, different instruments, and different samples, may on an average be set at* 1 *per cent.* [Expressed more exactly we might say that the limits of error are within ·97 per cent. of the total cane-sugar. Tr.]

The difference between the polarizations of the inverted sugar solutions was ·45 per cent. as a mean of 33 experiments. Here, to be sure, the Soleil saccharimeter alone was used.

3. Inversion, as the table shows, gave in only very few cases results differing considerably from direct polarization, a proof that the crude sugar contained little or no lævo-rotatory sugar.

In most cases the differences are within the errors of observation, and even with the less pure sorts are not so large that the amount of inverted sugar could be reckoned therefrom with safety.

Besides this, direct experiment with Trommer's test showed that in fact inverted sugar was absent in many samples, and in others was present in only small amount.

4. The last two columns furnish, in conclusion, an interesting addition to the table.

The first shows the polarization made at the time of purchase of the crude sugars in Magdeburg, and the latter those made after the arrival of the casks at Köln. These latter were made in March and April, by Counsellor Fleishauer, and sugar manufacturer Kirchner. The researches of Herr Lotman and myself were made in August and September, 1866, and a conversion of the figures obtained must show whether by lying in the casks the sugar had suffered an essential change or not.

In general it was found that the polarization fell off by lapse of time, yet in the majority of cases the difference fell within the error of observation of 1 per cent. (·97 per cent.).

A diminution of sugar contents might have been produced either by attraction of water or by a partial change of the cane-sugar into grape-sugar. The numbers contained in the table show that such a change had been produced after a lapse of half a year only on the minutest scale.

The original article contains, further, a series of experiments upon the determination of sugar by means of Fehling's copper solution (10 c. c. corresponding to ·05 grm. inverted sugar = ·0475 grm. cane-sugar), in which it was found judicious for the recognition, at the completion of the reaction, to bring a drop of the fluid upon a porcelain plate, together with a drop of acidified ferrocyanide of potassium.

At the point of contact arises, so long as oxide of copper is present, a fine brown line. The inversion of the sugar solutions was accomplished by warming them for 10 minutes with $\frac{1}{10}$ their volume of strong chlorhydric acid, to 70° or 80° C.

The following is a result of a comparison of titration with polarization, viz :—

Titration gives the contents in sugar sharper than polarization in diluted solutions, since the possible error of ·1 c. c. corresponds to ·03 grm. sugar in a litre, while with polarization, in the most favorable cases the error, as we have shown, might amount to ·15 grm. When the problem, therefore, is the investigation of very weak sugar solutions (beet juice, diabetic urine, etc.), the preference must be given to the copper method. But if, on the other hand, solid substances, like crude sugar, are to be examined by Fehling's method, we are compelled to prepare very dilute solutions, and in this case the errors occurring in titration have a great influence upon the calculation of the sugar contents of the dry substance.

This error could be lessened by the use of a larger amount of the copper solution than 10 c. c., yet for such assays polarization is undoubtedly much more judicious. Cases, nevertheless, may occur where, with the help of Fehling's solution, decidedly more correct results are obtained than with the polarizer, as with syrups and molasses, which contain, besides cane and grape-sugars, considerable amounts of other optically active substances, such as aspartic and other organic acids.

With such substances confused results are often obtained in applying Clerget's inversion process, while titration gives the amount of inverted sugar with much greater certainty, since the substances interfering with polarization have no influence upon the copper solution. Particulars in regard to this will be found in the chapter upon the analysis of syrups.

[*Note.*—I think this last statement, viz., concerning the superiority of the copper method over polarization, would have been greatly modified if the German *savans* had busied themselves with low grade sugars, Manillas for instance, instead of the excellent kinds on which they worked, only three in their thirty-three samples falling below 90 per cent. With very low grade East India sugars, I find that the dirt, gum, or whatever the indefinable organic matters present may be, acts strongly upon the copper solution, bringing out results that are incontestably too high. *Ex. gr.*, a sample of low grade Manilla, which by polarization gave as a mean of six determinations upon two separate samples 82 per cent. cane-sugar, gave 90·69 cane-sugar by the copper process, a figure which could be shown to be wrong, both by a complete analysis, and by practical results.—J. M. M.]

### B. *Determination of the Salts in Crude Sugar.*

The salts of crude sugar are mainly combinations of potassa with various organic acids, of which oxalic, malic, and citric have thus far been recognized.

If the sugar be incinerated in a platinum dish, a white residue remains, soluble in water, and consisting almost wholly of carbonate of potassa, and containing, as a rule, very small amounts of chlorine, sulphuric acid, soda, and lime.

Ordinarily, the residue which sugar leaves on incineration is reckoned as so much ash, or percentage of salts; but it is clear that this does not express the real amount of salts originally present in the sugar, but only the quantity of carbonate of potassa contained in these.

These numbers are useful merely to compare the relative amount of salts contained in different sugars.

Scheibler* proposes incineration with the addition of concentrated sulphuric acid, whereby combustion goes on more rapidly.

In this case sulphates remain as a residue, and the percentage of ash is perhaps $\frac{1}{10}$ higher than by the first method. Since the equivalent of sulphuric acid is nearer that of the organic acids than carbonic acid, the numbers obtained by Scheibler's process stood nearer the true values, but obviously do not give the true per cent. of salts, and are therefore useful only as a means of comparison. We can hardly find a method applicable in practice for the direct determination of organic salts in crude sugars, molasses, etc., but nevertheless the following indirect way may be used.

As has been remarked, the organic salts contain principally potassa combined with oxalic, citric, and other organic acids. These acids can be precipitated with acetate of lead, and if the precipitate be decomposed with sulphydric acid, the filtrate contains the free acids, which, if neutralized with potassa, give with tolerable exactness the salts of the crude sugar. If we determine by experiment how much carbonate of potassa a definite weight of the dry salts leaves behind upon incineration, by means of this number reversed we can estimate from the ash of a sugar its contents in organic salts.

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*Zeitschrift des Vereins für Rübenzucker Ind. Bd. 14, p. 188. Jahresbericht über die untersuchung, und Fortschritte auf dem Gesammt gebiet der Zuckerfabrikation von Scheibler und Stammer, Bd. 4 p. 221.

For executing this experiment crude sugar was not employed, but syrup, prepared from this sugar, on account of its greater percentage of salts, and of this two pounds were used. The lead precipitate was, of course, treated with water so long as any sugar could be washed out. The acid fluid obtained after decomposition by sulphydric acid was exactly neutralized with solution of potassa, partly evaporated and filtered over animal charcoal that had previously been washed with chlorhydric acid. After complete drying on a water-bath, there remained a faintly yellow colored crystalline deposit.

This readily deliquesced in the air, and by the ordinary reactions oxalic, malic, and tartaric acids were detected, while the presence of citric acid was doubtful.

It also contained chlorine, and a trace of sulphuric acid. This mass of salts served for the following determinations:—

(1) ·7645 grm. of the substance dried at 100°, until its weight became constant, gave ·3745 grm. potassic carbonate.

(2) 2·1842 grm. of the same gave 1·065 grm. potassic carbonate.

(3) 3·5325 grm. of the same gave 1·784 grm. potassic carbonate.

Reckoning from this the amount of organic salt to which one part of the residual potassic carbonate corresponds, we have:—

Exp. 1. = 2·04 parts.
„ 2. = 2·05 „
„ 3. = 1·98 „

Hence, as an average we may assume that the organic salts of crude sugars and molasses, on incineration, leave half their weight of potassic carbonate.

If crude sugar be incinerated in a platinum dish the complete combustion of the carbon demands considerable time, since the carbon itself, towards the close of the operation, is enveloped in the melted salts. This inconvenience may be avoided by burning the mass to coal, lixiviating this with water, and completing the incineration of the carbon by itself. The aqueous solution of the salts must be brought back into the platinum dish, evaporated, and heated to redness. This process requires more time than the first.

If we determine the percentage of ash by heating in an open platinum dish until the carbon completely disappears, as was always done in the case of the sugars examined in this research, a part of the resultant carbonate of potash volatilizes in consequence of the long-continued high heat.

That this is in fact the case is shown by the flame from a Bunsen burner taking on an intense violet hue when held in the current of air rising from the heated dish. In order to determine the magnitude of the error thus arising, and to be able to correct the same, the loss which the sugar residue suffered by heating for a greater or less time was determined by some special experiments which have given the results annexed, viz.:—

(1) 1·4798 gramme of crude sugar was incinerated over a Bunsen burner with the weakest possible flame, an operation which required 35 minutes. The residue was then repeatedly heated and weighed.

| | | Loss. |
|---|---|---|
| Weight of residue after incineration | ·0347 grm. | |
| ,, ,, ,, ¼ h. heating .. | ·0335 ,, .. | ·0012 |
| ,, ,, ,, ½ ,, .. | ·0325 ,, .. | ·0010 |
| ,, ,, ,, ¾ ,, .. | ·0315 ,, .. | ·0010 |

(2) 3·009 grms. crude sugar were completely incinerated in 45 minutes. The ash was then further burned.

| | | Loss. |
|---|---|---|
| Weight of original ash . . . . . | ·0695 grm. | |
| ,, after ¼ h. heating . . . . | ·0677 ,, .. | ·0025 grm. |
| ,, ,, ,, . . . . | ·0642 ,, .. | ·0028 ,, |
| ,, ,, ,, . . . . | ·0615 ,, .. | ·0027 ,, |
| ,, ,, ,, . . . . | ·0595 ,, .. | ·0020 ,, |
| ,, ,, ,, . . . . | ·0575 ,, .. | ·0020 ,, |
| ,, ,, ,, . . . . | ·0530 ,, .. | ·0045 ,, |
| ,, ,, ,, . . . . | ·0450 ,, .. | ·0080 ,, |
| ,, ,, ,, . . . . | ·0390 ,, .. | ·0060 ,, |

(3) 2·946 grms. crude sugar left behind

| | | Loss. |
|---|---|---|
| After incineration . . . | ·045 grm. | |
| ,, ¼ hour further heating | ·0395 ,, | ·0055 grm. |

These experiments show that the volatilization of equal quantities of salts is proportional to the duration of the heating, and that this loss is more considerable the greater is the mass of the salts.

From the numbers obtained is arranged the following table, showing the loss which different quantities of ash of sugar can experience by ignition.

| Weight of Residue. | Loss by heating. | | | |
|---|---|---|---|---|
| | ½ hour. | 1 hour. | 1½ hour. | 2 hours. |
| ·01 grm. | ·002 grm. | ·004 grm. | ·006 grm. | ·008 grm. |
| ·02 ,, | ·002 ,, | ·004 ,, | ·007 ,, | ·008 ,, |
| ·03 ,, | ·002 ,, | ·005 ,, | ·008 ,, | ·010 ,, |
| ·04 ,, | ·003 ,, | ·006 ,, | ·009 ,, | ·012 ,, |
| ·05 ,, | ·004 ,, | ·007 ,, | ·011 ,, | ·015 ,, |
| ·06 ,, | ·004 ,, | ·008 ,, | ·013 ,, | ·017 ,, |
| ·07 ,, | ·005 ,, | ·010 ,, | ·015 ,, | ·019 ,, |
| ·08 ,, | ·005 ,, | ·010 ,, | ·016 ,, | ·020 ,, |

Of the crude sugars to be examined 2 to 3 grms. were employed which left from ·02 to ·06 grm. residue.

Since the time required for full combustion of the carbon had already been noted, the loss by volatilization could be corrected at least approximately by means of the above table.

This correction, in many cases, is not at all inconsiderable, in view of the small amount of ash left by the sugars.

Ex. 92—2·7705 grms. of a certain sample of crude sugar left ·0305 grm. ash = 1·10 per cent. residue. Since the incineration had lasted an hour, about 5 mgrms. of salt must have been volatilized in this time, so that the corrected weight of the ash is ·0355 grm., corresponding to 1·28 per cent.

In conclusion, therefore, it may be said that in order to reckon the amount of *organic salts* present in the crude sugar, from *the corrected percentage of ash, it is necessary simply to double the numbers found.* If, however, Scheibler's incineration process with sulphuric acid be employed, the weight of the residue should be multiplied by 1·54.

This calculation may be adopted without scruple in samples of crude sugar in general, since the ash consists almost wholly of carbonate of potash.

Insoluble inorganic constituents (sand), which might increase the weight of the residue, were present in considerable amount only in crude sugar No. 27. It amounted here to one per cent., and was subtracted in reckoning the organic salts.

[*Note.* In the low grade sugars imported largely into this country, it is absolutely necessary to determine the amount of insoluble inorganic matter before reckoning the true ash. Sand and small pebbles abound in low grade East India sugars, and the true ash must be determined either—as is frequently my own method—by evaporating and igniting an aliquot part of a filtered solution of known strength, or by incinerating the crude sugar, and washing out the soluble part. The first is rather the better way.—J. M. M.]

To determine the possible error arising from the difference of the samples, the percentage in salts of No. 5 was repeatedly determined.

| | Sugar in grms. | Ash. | Per cent. | Time. | Loss by volatilization. | Corrected ash. | Per cent. | Organic salts in per cent. |
|---|---|---|---|---|---|---|---|---|
| 1 | 3·3415 | ·0435 | 1·30 | 1½ | ·009 grm. | ·0525 grm. | 1·57 | 3·14 |
| 2 | 2·5327 | ·0355 | 1·40 | 1 | ·005 ,, | ·0405 ,, | 1·60 | 3·20 |
| 3 | 3·483 | ·0390 | 1·12 | 1½ | ·009 ,, | ·0480 ,, | 1·38 | 2·76 |
| 4 | 2·5375 | ·030 | 1·18 | 1¼ | ·007 ,, | ·0370 ,, | 1·46 | 2·92 |
| Mean .. .. .. | | | 1·25 | .... | .......... | .......... | 1·50 | 3·00 |
| Error of samples | | | ±·14 | .... | .......... | .......... | ±·11 | ±·22 |

The results of the salt determinations of the 33 sugars are given in Table III.

### C. *Determination of the Water in Crude Sugar.*

The percentage of water in all the samples of crude sugar was determined by direct drying at a temperature of 55°-60° C.

An air-bath with a Bunsen's regulator was employed.

Ordinarily from 2 to 3 grms. of sugar were used, and the sample was weighed between watch-glasses, on account of its extreme hygroscopicity in its dry condition.

The dehydration of the sugar was completed in two hours—as two preliminary experiments showed—no further loss occurring, yet generally the samples were allowed to remain a longer time, viz., 4 or 5 hours in the air-bath.

In order to estimate the influence of the possible dissimilarity of the samples used upon the water determination, three different samples of crude sugar, No. 5, were taken, which gave the numbers 2·22, 2·24, 2·18, per cent.

The error which may occur in the water estimation may accordingly be set at ± ·03 per cent.

The water percentage of the crude sugar may further be determined in an indirect way, by the determination of the specific gravity of the normal solution prepared for Ventzke's saccharimeter, which contains 26·048 grms. of sugar in 100 c. c. of water.

Two spindles made for this purpose by Geissler of Bonn, and Pawlowski of Berlin, and which agree very well with each other, served for this purpose. With these the third decimal can be read and the fourth estimated.

The accuracy of these instruments was tested by means of a solution of pure sugar of 1·10 sp. gr. The correction for the normal temperature, 17·5° C. was taken from Gerlach's tables, and the saccharometric dry substance, as well as the amount of water, was reckoned from those of Brunner.*

If these indirect water determinations, which in the sugar-house are often made, be compared with the direct, it will be found that the first are in all cases too low, about ·44 per cent. on an average. The cause, as may easily be seen, lies in the fact that the salts of the crude sugar, since they are specifically heavier than pure sugar, cause the sp. gr. of Ventzke's normal solution to be somewhat too high. In order to obtain the true percentage of water, the amount shown by the spindle must be increased ·4 per cent.

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* Zeitsch. d. Vereins f. Rubenzucker, M.D., 1861, p. 34.
Stammer's Taschenbuch f. Zuckerfabr, p. 63.
Zeitsch. d. Vereins f. Rubenzucker, M.D., 1861, p. 32.
Stammer's Taschenbuch, p. 60.
[See, also, a very handy little book, Leitfaden zar antersachung der ferscheidenen Zuckeraster, etc. Von Clement Mondelbluh. Brunn, 1867.—J. M. M.]

The following Table II. contains a comparison of the direct and indirect water determinations.

TABLE II.

| No. | Per cent water by drying. | Sp. gr. Ventzke sol. | Per cent. water calculated. | Difference between direct and indirect water determination |
|---|---|---|---|---|
| 1 | 2·01 | 1·0986 | 1·74 | ·58 |
| 2 | 2·33 | 1·0983 | 1·47 | ·59 |
| 3 | 2·46 | 1·0978 | 2·24 | ·22 |
| 4 | 3·27 | 1·0975 | 2·55 | ·72 |
| 5 | 2·22 | 1·0980 | 2·04 | ·18 |
| 6 | 3·35 | 1·0971 | 2·95 | ·40 |
| 7 | 2·76 | 1·0975 | 2·55 | ·21 |
| 8 | 2·82 | 1·0980 | 2·04 | ·78 |
| 9 | 2·57 | 1·0977 | 2·35 | ·22 |
| 10 | 3·04 | 1·0978 | 2·24 | ·80 |
| 11 | 2·93 | 1·0973 | 2·75 | ·18 |
| 12 | 2·33 | 1·0983 | 1·74 | ·59 |
| 13 | 3·53 | 1·0968 | 3·25 | ·28 |
| 14 | 3·12 | 1·0975 | 2·55 | ·57 |
| 15 | 2·80 | 1·0977 | 2·35 | ·45 |
| 16 | 2·61 | 1·0980 | 2·04 | ·57 |
| 17 | 2·69 | 1·0976 | 2·45 | ·24 |
| 18 | 2·25 | 1·0984 | 1·64 | ·61 |
| 19 | 2·86 | 1·0974 | 2·65 | ·21 |
| 20 | 3·11 | 1·0973 | 2·75 | ·36 |
| 21 | 2·69 | 1·0979 | 2·14 | ·55 |
| 22 | 2·99 | 1·0975 | 2·55 | ·44 |
| 23 | 4·31 | 1·0962 | 3·85 | ·46 |
| 24 | 2·82 | 1·0975 | 2·55 | ·27 |
| 25 | 3·51 | 1·0968 | 3·25 | ·26 |
| 26 | 3·66 | 1·0968 | 3·25 | ·41 |
| 27 | 2·47 | 1·0982 | 1·84 | ·63 |
| 28 | 2·60 | 1·0978 | 2·24 | ·36 |
| 29 | 3·69 | 1·0964 | 3·65 | ·04 |
| 30 | 3·35 | 1·0973 | 2·75 | ·60 |
| 31 | 3·81 | 1·0967 | 3·35 | ·46 |
| 32 | 3·04 | 1·0975 | 2·55 | ·49 |
| 33 | 4·05 | 1·0967 | 3·35 | ·70 |

*(To be continued.)*

# Notes.

## REFINED SUGARS AND SUGAR REFINERIES.

The United States consume a pretty sizeable lump of sugar each year. The crop of Louisiana sugar, all used in the States, was 108,520 hogsheads the past year. But this is only a drop in the bucket—scarcely worth naming. We import sugars of the value of ninety-two millions of dollars, sixty millions of it for Cuban sugar alone. In 1872 we imported 64 per cent. of all the Cuban crop of sugar, and 91 per cent. (200,000 tons) of her molasses. Although a few of our largest sugar planters make, by improved and costly machinery, double refined sugar of most of their crops, the Cuban planters find most profit in making low grade raw sugars for us to refine. In the great importing cities of New York and Boston, full of capital and of manufactories, it may easily be conjectured there are required very extensive sugar refineries to use up their proportion of the ninety-two millions of sugar importations. There is also a little establishment of this kind in St. Louis, known as Belcher's. It pays about a million dollars in duty annually on the raw sweets imported mostly from Cuba; and it last year refined and sold a sufficiency of nicely barreled refined sugar to bring in the respectable sum of five millions of dollars, while the sales for July and August, just passed, foot up twelve hundred thousand dollars. This business is all done on the manufactory's own money, too, independent of credit. Its importations are done by letters of credit on London. People are too refined these days to consume anything inferior to the refined or double-refined article. The raw sugar, hogshead system, caused too great a loss in handling, shipping, tare, &c. The refined article, too, is all sold for cash, a more refined way of doing business, so that the manufactory is out of debt, and the purchasers and consumers are, per force, in the same happy condition.

The *Natal Mercury* says that in reply to a memorial from Victoria county planters, His Excellency Sir B. Pine, has expressed his anxiety to devise means for improving the labour supply of the colony, and has stated that Mr. Shepstone, Secretary for Native Affairs, has been instructed to arrange with Cetywayo, the Zulu King, for the safe conduct of labourers from other tribes through his country, and for the establishment in Zululand of an agent of the Government, whose duty it shall be to assist labourers passing through to Natal.

We give the following from the same paper:—" It is early so far to speak of the promise of the crops. Most of the sugar mills are at work, and an excellent quality of sugar is being made, both by the vacuum pan and the wetzel processes. The want of labour only prevents the very large extension of sugar planting. People are more and more coming to the belief that the central factory system secures the maximum of profit both to the grower and the manufacturer, and were labour plentiful—as we hope it soon will be—several of these fabrics would be established. Accounts of the outturn of cotton vary. The fly is complained of here and there, but we hear of a fair crop also. The coffee crop this year we have already pronounced to have been a comparative failure, the yield on many plantations being insufficient to cover current expenses. On the other hand, a fine blossoming is promised for the spring, and it is thought that next season's crop may help to compensate for the poor returns of the last two years."

## AN ADVANCE IN SUGAR-MAKING.

During last crushing season, it was announced that Messrs. Tooth and Cran, of the Yengarie Refinery, had perfected a system which enabled them to check the incipient fermentation in cane liquor as it left the mill, and that as treated by them the liquor would keep sweet for weeks, and could be conveyed long distances in tanks or otherwise. The system was not put into use last season, but as announced by advertisement in our columns several weeks since, the proprietors of Yengarie lost no time this season in announcing that they are prepared to purchase cane liquor, to treat it under the process patented by them, and to convey the liquor to the Yengarie Refinery for conversion into sugar. The announcement naturally caused a good deal of excitement amongst cane-growers and sugar-makers, who can see the means of a vast extension of sugar production in the ability to check fermentation in cane liquor. Mr. Tooth, who was in Brisbane during the week, left with us a sample of the sugar now being made at Yengarie, and kindly furnished a few notes upon the process followed, which will be of interest to planters generally: The firm are now taking delivery of liquor from a mill on the Mary River. As it leaves the rollers the liquor is treated with a chemical agent, for which patents are held in all the colonies. The liquor is then stored in tanks, and when a cargo is obtained it is sent on to the factory for conversion into sugar by a process different from any yet followed. The result is a pure white sparkling sugar, worth in Brisbane £42 per ton. At the present time the value of liquor at 10° density as delivered into the tanks considered equal (per gallon) to 1 lb. of raw sugar, worth, to the grower of the cane, about £23 per ton, without any deductions. This, we believe forms the basis of the calculations of the firm, who buy liquor of greater or less density at proportionate prices. They purpose putting a floating mill on the Mary, with punts and tanks for the reception and conveyance of the liquor. With this plant they will be able to take off the crop of the farmer, without the cost of conveying the cane long distances, and to return him the megass for manure. We have no doubt that such a system would give an immense impulse to cane-growing and the production of sugar, for hundreds of acres on all the principal rivers, now beyond the reach of mills, would, were the crop disposable in this way, be put under cane—the most profitable crop at the option of Australian farmers.

The importance of the advance made by Messrs. Tooth and Cran must force itself upon every one who has at heart the future welfare of this country. We require an established agricultural population, and the process seems to meet the want that is felt for the extension of cane farming, and in the best way. At present, with all the skill and care engaged in it, sugar is still manufactured imperfectly, and there is considerable loss. By this new process the finest sugar is made, and we understand the whole of the sugar in the cane juice is made of the quality forwarded to us; but we hope at no distant date to report what we can testify by a personal inspection. It seems to us that this discovery, if the facts are borne out as stated, will revolutionize the sugar industry of this country, and indeed that of the world.—*The Queenslander.*

# Correspondence.

## SUGAR EXPORTS OF THE HAWAIIAN ISLANDS.

To the Editor of "The Sugar Cane."

Sir,

Your issue for March contained an article upon these Islands as "the future sugar country of the United States in the Pacific," and in connection therewith and in response to your request that something thereon be contributed, that Hawaii in fact might be represented in the pages of *The Sugar Cane*, together with other sugar-producing countries, I have compiled the accompanying tables, which I trust will be serviceable in placing us in a proper position before the world as a sugar-producing country. For the use of the tables since 1852 I am indebted to our Collector-General of Customs and his Deputy, and in gathering for the earlier years of sugar exports I have not as yet been able to find the figures for 1842.

The first sugar exports from these Islands was in 1837, when 4,286 lbs. sugar and 2,700 galls. molasses were exported. This was before the establishment of Customs Regulations in the kingdom; and the figures we have for data are from merchants' published statements, and are not complete nor continuous, as for instance,—1837, exports as given above; 1838, 88,543 lbs. sugar, 11,500 galls. molasses; 1839, 100,000 lbs. sugar, 75,000 galls. molasses; 1840, from January to August, 360,000 lbs. sugar, 31,739 galls. molasses; from August, 1840, to August, 1841, 60,000 lbs. sugar and 6,000 galls. molasses; after this there are no figures given until 1843, so I have prepared the following tables from that year. These will be followed by Notes on the History of the Sugar Industry of the Hawaiian Islands, which I have now in the course of preparation, and will be forwarded you shortly.

Yours truly,

Thos. G. Thrum.

*Honolulu, September 6th, 1873.*

## YEARLY EXPORTS OF SUGAR AND MOLASSES FROM THE HAWAIIAN ISLANDS, SINCE 1843.

| Year. | Lbs. Sugar. | Galls. Molass. | Year. | Lbs. Sugar. | Galls. Molass. | Year. | Lbs. Sugar. | Galls. Molass. |
|---|---|---|---|---|---|---|---|---|
| 1843 | 1,145,010 | 64,320 | 1853 | 642,746 | 75,769 | 1863 | 5,292,121 | 114,413 |
| 1844 | 513,684 | 27,026 | 1854 | 575,777 | 68,372 | 1864 | 10,414,441 | 340,436 |
| 1845 | 302,114 | 19,353 | 1855 | 289,908 | 38,804 | 1865 | 15,318,097 | 542,819 |
| 1846 | 300,000 | 16,000 | 1856 | 554,805 | 58,842 | 1866 | 17,729,161 | 851,795 |
| 1847 | 594,816 | 17,928 | 1857 | 700,556 | 48,486 | 1867 | 17,127,187 | 544,994 |
| 1848 | 499,533 | 28,978 | 1858 | 1,204,061 | 75,181 | 1868 | 18,312,926 | 492,839 |
| 1849 | 653,820 | 41,235 | 1859 | 1,826,620 | 87,513 | 1869 | 18,302,110 | 338,311 |
| 1850 | 750,238 | 129,432 | 1860 | 1,444,271 | 108,613 | 1870 | 18,783,639 | 216,662 |
| 1851 | 21,030 | 43,742 | 1861 | 2,562,498 | 128,259 | 1871 | 21,760,773 | 271,291 |
| 1852 | 699,170 | 62,030 | 1862 | 3,005,603 | 130,445 | 1872 | 16,995,402 | 192,105 |
| | | | For the six months from January to July of 1873 | | | | 13,726,606 | 35,337 |

TABLE SHOWING TO WHAT COUNTRIES THE ABOVE HAS BEEN EXPORTED SINCE 1860.

| Year. | Pacific Ports, U.S. | | Atlantic Ports, U.S. | | German Ports. | | British Columbia. | | Russian Possessions. | | All other Ports. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Lbs. Sugar. | Galls. Mol. | Lbs. Sugar | Gals. Mol. | Lbs. Sugar. | Galls. Mol. | Lbs. Sugar. | Galls. Mol. | Lbs. Sugar. | Galls. Mol. | Lbs. Sugar. | Galls. Mol. |
| 1860 | 1,090,498 | 76,402 | 200 | .. | .. | .. | 333,813 | 29,921 | 8,500 | 90 | 11,260 | 2,200 |
| 1861 | 2,036,961 | 64,552 | .. | 90 | 250 | .. | 520,777 | 60,784 | 3,000 | .. | 1,410 | 2,833 |
| 1862 | 1,656,159 | 78,066 | 244 | .. | .. | .. | 1,342,538 | 51,894 | .. | .. | 6,662 | 485 |
| 1863 | 3,844,348 | 36,021 | 1,015 | .. | 130 | .. | 1,432,274 | 57,381 | .. | .. | 14,354 | 21,011 |
| 1864 | 9,986,231 | 293,144 | 2,056 | 5,547 | .. | .. | 423,881 | 21,731 | .. | .. | 102,273 | 20,014 |
| 1865 | 14,268,134 | 448,802 | 3,790 | .. | .. | .. | 1,016,991 | 22,464 | 25,441 | 1,455 | 3,741 | 70,098 |
| 1866 | 16,807,991 | 819,793 | 7,709 | 2,019 | 121 | 780 | 830,143 | 26,079 | 67,702 | 2,463 | 15,495 | 661 |
| 1867 | 16,574,961 | 412,161 | 11,885 | 13,361 | 8,160 | 7,895 | 502,980 | 9,515 | .. | .. | 29,201 | 102,062 |
| 1868 | 17,551,815 | 342,001 | 1,590 | 20,481 | 730 | 36,144 | 753,913 | 93,481 | | | 4,878 | 732 |
| | | | | | | | | | Aust. & New Zealand | | | |
| 1869 | 16,804,725 | 143,085 | 1,776 | 8,721 | 648,546 | 87,952 | 844,742 | 92,591 | | | 2,321 | 5,962 |
| 1870 | 14,512,966 | 35,265 | 44,745 | 24,003 | 308,326 | 38,160 | 1,020,070 | 46,227 | 2,838,698 | 4,380 | 58,834 | 68,627 |
| 1871 | 18,134,720 | 164,546 | 780 | 168 | 130 | 7,114 | 933,085 | 64,093 | 2,672,071 | 32,197 | 19,987 | 3,173 |
| 1872 | 14,407,598 | 96,421 | 128 | 40 | 123 | .. | 1,245,892 | 69,210 | 1,320,657 | 22,255 | 21,002 | 4,179 |

## SUGAR STATISTICS—GREAT BRITAIN.

To October 11th, 1873 and 1872. In Thousands of Tons, to the Nearest Thousand.

| | STOCKS. | | | | | | IMPORTS. | | | | | | DELIVERIES. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. |
| British West India | 33 | 2 | 1 | 32 | 68 | 72 | 96 | 17 | 12 | 52 | 177 | 163 | 79 | 17 | 12 | 36 | 144 | 111 |
| British East India | 15 | 2 | .. | .. | 17 | 9 | 21 | 4 | .. | .. | 25 | 20 | 16 | 5 | .. | .. | 21 | 18 |
| Mauritius ...... | 3 | 1 | .. | .. | 4 | 4 | 13 | 3 | 12 | 11 | 39 | 39 | 14 | 3 | 12 | 12 | 41 | 41 |
| Cuba .......... | 3 | 7 | 1 | 22 | 33 | 37 | 10 | 16 | 19 | 59 | 104 | 110 | 12 | 10 | 19 | 49 | 90 | 83 |
| Porto Rico, &c. .. | 1 | 12 | .. | 5 | 18 | 14 | 4 | 30 | 1 | 15 | 50 | 32 | 5 | 21 | 1 | 10 | 37 | 22 |
| Manilla & Java .. | 29 | 11 | .. | 2 | 42 | 20 | 26 | 11 | 7 | 6 | 50 | 48 | 18 | 6 | 7 | 8 | 39 | 51 |
| Brazil .......... | 4 | 27 | 1 | 5 | 37 | 24 | 12 | 62 | 5 | 11 | 90 | 84 | 10 | 48 | 5 | 11 | 74 | 73 |
| Beetroot, &c. .... | 2 | .. | .. | .. | 2 | 1 | 26 | 8 | 6 | 19 | 59 | 60 | 30 | 10 | 8 | 30 | 78 | 72 |
| Total, 1873 .. | 90 | 62 | 3 | 66 | 221 | 181 | 208 | 151 | 62 | 173 | 594 | 556 | 185 | 119 | 64 | 156 | 524 | 471 |
| Total, 1872 .. | 74 | 32 | 7 | 68 | 30 increase | | 173 | 114 | 65 | 204 | 38 increase | | 138 | 111 | 62 | 160 | 53 increase | |

# THE STATE AND PROSPECTS OF THE SUGAR MARKET.

The month of October opened with a firm market for Raw sugar; the confident tone on the part of holders, which characterized transactions in Raw throughout September, still continued, and up to about the middle of the month a considerable business was done at prices generally higher than those quoted in our last number. For the last fortnight, however, there has been a much less buoyant tone, and indeed latterly considerable dulness has prevailed, especially in London, so that the latest reports, although showing little quotable alteration in price, represent a considerable diminution in the amount of business transacted.

Present quotations compare with those of last month as follows:—No. 12 Havana afloat, 26s. 6d. to 27s., showing no alteration; fair to good refining Muscovadoes, 23s. to 23s. 6d., or an advance of 1s. 3d. per cwt.; middling to good brown Bahia, 18s. 6d. to 19s. 6d., against 17s. 6d. to 18s. 6d. last month.

The stock of Raw sugar at the four ports continues to decrease, and the consumption for the year is in excess of that of the same period in any previous year, and far exceeds that of 1872. These are circumstances which do not foretell lower prices, but on the other hand we must note that the prospects of the Beetroot crop are very favorable, and that our refined markets are at present being so inundated with foreign goods, offered at prices so ruinously low to the British refiner, that several of these (including some Clyde houses) have been compelled to cease work, and it is certain that the others cannot long consent to remain working with the inadequate margin at present offered.

# THE
# SUGAR CANE.

No. 53. DECEMBER 1, 1873. Vol. V.

☞ The writers alone are responsible for their statements.

*For Table of Contents, see opposite the last page of each Number.*

## ON THE PHYSICAL STRUCTURE OF CANE SOILS AND THEIR MOISTURE.

By Dr. T. L. Phipson, F.C.S., &c.

There is much information to be gained concerning the yield of any given soil by observing the quantity of moisture it will give the analysis in certain conditions. It is well known that cane fields suffer considerably from drought, and the extent of this suffering is in inverse ratio to the power of the soil to retain moisture. This power, again, is intimately connected with the physical structure of the soil.

This is so true that if we take for example three soils possessing all the elements of fertility, each of them capable of yielding, in ordinary seasons, good crops of sugar for 10 or 15 years at least, we shall find that their resistance to dry seasons will be in exact ratio to the quantity of moisture found under certain special circumstances, which I will presently explain. Let us call these three soils, A, B, and C, and note that the remarks which ensue are not imaginary or theoretical, but the actual results of experiments with three West Indian soils. A has given 15 per cent. of moisture, B 11½, and C 5 per cent.; and I have found that these figures 5, 11½, and 15, show very precisely the capabilities possessed by each of these soils to resist a dry season; so that, under such circumstances A will yield a crop twice as large as that of B, and three times as large as that of C. It has even been found that irrigation, unless applied very constantly, will not render B and C as productive as A is without irrigation.

These three soils lie within a comparatively short distance of each other, but their physical structure is very different:—A is an ordinary specimen of grey Demerara clay, containing its usual amount of humus, or organic matter; it is almost a virgin soil, and rather too compact for easy working. B is a clay of the same nature, but containing less organic matter, and a considerable quantity of of small flinty pebbles about the size of peas and beans. C has also a basis of clay, but it is very largely admixed with fine quartz or sand, and its organic matter is not larger than that of B.

The peculiar physical structure of these three soils, accounts perfectly for their respective energies in retaining moisture, and their yield in a dry season is, as nearly as possible, in exact ratio to the figures 5, 11½, and 15.

Special care is requisite in the Laboratory to obtain these figures, and perhaps the simplest method is, after breaking up the samples, to weigh out about ¼lb. of each, and to leave the three samples spread out on coarse paper to an atmosphere at 17° Centigrade for 24 hours, after which the moisture is determined by subjecting a small portion of each to a temperature of 102° Centigrade.

*Laboratory of Analytical Chemistry, Putney, S.W.,*
*London, 5th November, 1873.*

## EXPLANATION OF GILL'S NEW PROCESS FOR PURIFYING THE JUICE OF THE SUGAR CANE, TO REALISE AN INCREASED SUGAR PRODUCT.

By W. Eathorne Gill.

Some little time has passed since I promised to renew this subject; delay has not been my choice, it has been enforced by accidents which affected others much more—as breaking of machinery, burning of megass loges, &c., misfortunes which, although they may not come alone, must become my apology here.

We are all aware that in the common practice of boiling together the impurities of the cane juice with its contained sugar, the latter suffers, and the planter loses more sugar than he sells. This has been proved *ad nauseum.* Again, the misnamed purification, by adding lime to the juice, has been abundantly demonstrated as making matters worse; yet, it must be admitted that without lime we cannot get sugar in a crystalline state, where acetification has been allowed. Complexity begins with the expression of the juice, to end in extravagant loss. We may not shut our eyes to such facts, they are too formidable to be treated with contumely by those who consult their own interests. The difficulty of removing them is also formidable, so that they remain, notwithstanding the assaults of some of our ablest scientific men, aided by experienced, practical planters. Money has not been stinted, witness the expensive vacuum pans sown broadcast over our islands in the West Indies, and the loss of sugar remains to annoy all concerned.

The problem before us has engrossed my attention these many years, and I have been helped to its solution by the discoveries of Faraday, who was one of our most brilliant philosophers. By putting those discoveries to a practical use, I succeeded in disposing of the appliances so as to evoke galvanism by the cane juice itself, sufficient to coagulate the albumen, albumenoids, gummy matters, &c., causing impurities to separate from the juice, and float as scum. Thus fermentation is arrested immediately after the cane juice has left the mill, by coagulating and rendering inert the causes of fermentation, and thus reducing, if not entirely obviating the necessity for lime and its evil consequences. All the "cush, cush," *i.e.*, comminated particles of cellulose, and all earthy matters, are precipitated, collected, and removed without any trouble or impediment to the usual progress of routine, and the juice is filtered "without souring." The cane juice passes on, with an uninterrupted flow, into the clarifier, where the temperature is raised to expand such starch-granules as may have escaped there, until they float, to be collected and removed as black scum. This being carefully attended to, but little scumming, if any, remains to be done; the juice may then be boiled freely, and run off into the evaporating pans ("copper wall"). The finish of this boiling process should be approached with becoming caution, and at as low a temperature as possible.

The cane juice, purified by this process, is distinguished, on leaving the clarifier, by being "clear, clean, bright, and of the colour of pale sherry." Even this amount of colour can be reduced to insignificance, when causing the juice to filter by ascension through vegetable or animal charcoal, in the same apparatus or tank, simply at the expense of the charcoal only.

It is by this simple process, without impediment to the usual routine, or the addition of anything, "good, bad, or indifferent," that the well-known impurities are separated without souring the juice.

Whatever may be present in the juice, that is not sugar, are treated as impurities, and separated according to the law which governs each of them, and that before lime can be employed to "make confusion worse confounded," to increase the loss of sugar. Of course the refiner's task will now be an easy one, his task was to remove impurities from sugars, nothing more.

After all, neither this simplicity, nor complete perfection of process, whenever attained, can abrogate those fundamental laws by which chemical action is governed. It will be at once admitted that temperature has much to do with success in boiling sugar, to which the well-known vacuum pan bears sufficient witness. A modern French writer puts the limit at 40° C. or 104° F. Where pure juice is employed, a good grocery sugar can be obtained at a moderate temperature in an open pan. So also, whoever indulges an extravagant temperature will reap a degenerated sugar, more or less loaded with molasses.

The best proof of the practical value of all this, that I can afford, is some extracts from Mr. Stephenson's letters to me. That gentleman is the manager of Plantation Hague, West Coast, Demerara. I understand that some alterations are contemplated there, and these trials, in my absence, were tentative to satisfy certain requirements. There was no alteration of the plant whatever, beyond the addition of my tank and its contents; through this tank the cane juice flowed on its way from the mill to the clarifier. They usually made 30 hogsheads of sugar weekly, and continued to do so when my process was tried, but with a less expenditure of cane juice. Had the quantity of cane juice continued as before, the yield of sugar must have been much more. This could not be done, for they had already arrived at the limit of their evaporating ability, and even that was accomplished at an "awfully high" temperature, of course at the expense of the quality of the sugar product.

Mr. Stephenson says, "The cane juice went through the separator quite nicely, throwing up quantities of thick scum to the surface of contained liquor, which passed on to the clarifiers as usual, and thence to "the copper wall." The juice was now bright and clear, of the colour of pale sherry, allowing us to drain off every drop from the clarifier. The clarification of the cane juice is now quite perfect. I feel confident that immense results will be obtained from your process; in no manner or degree do I attach the slightest doubt as to the working of your process. There was a very marked difference in the time it took to boil off the liquor, compared with the usual common process."

In the letter which I received per last mail he says, "The quality of the cane juice is so poor that it is boiling away dreadfully, the density being barely 8° B. There has never in my recollection been such complaints about the bad yield of cane juice as at present. Some estates taking upwards of 3,000 gallons of cane juice per hogshead of sugar, all canes being so very short and dry. It is very satisfactory for you to know that we have not taken so many gallons of cane juice per hogshead as was to be expected in consequence of the very late harrowing; indeed, they are not yet burst. Of the juice I hear of nothing over 13° Twaddle in our district and up the river. I therefore had some misgivings. We did not have any souring. I have much pleasure in stating that, as before, the clarification seemed perfect, the liquor running down very clear and clean, and of the colour of pale sherry. The results you anticipate are almost realised. I say almost, for what delicate fluid, like cane juice, could stand the awful temperature of our "copper wall." When finished at a low temperature I feel confident that immense results would be obtained from your process."

As facts are always of the highest value, let us appeal, therefore, to the highest authority. On their first trial by my process they used 1,814 galls. of cane juice (at 9° B.) per hhd. of 42in. truss; on the second occasion, 1,600 galls., at 9° B.; and on the third, we see that they used 2,181 galls. of 8° B. That is, they had run a fortnight continuously, had expressed in that time 130,860 galls. of cane juice, and had made 60 hhds. of sugar with the juice treated on my process, and that without souring or impediment of any kind; when their immediate neighbours were using upwards of 3,000 galls. per hhd., or $3,000 \times 60 = 180,000$ galls. for 60 hhds. The difference is about 49,140 galls, and $\frac{49140}{2181} = 22{\cdot}5$ *hhds. of sugar more by my process from that quantity of juice than by the common process.* These 22 hhds. of sugar must be now clear profit on a fortnight's work with my process. This interesting fact acquires importance in the face of the beet sugar competition, particularly when the crop of canes, as at present, is so near a minimum, and their juice of an inferior quality.

It will be seen, by practical men, that these are rather severe trials of the pretensions of my process; in fact, they are only surpassed by a subtle challenge which I once accepted, to do what the challengers, who were piqued, confessed they could not do, and was offered rotten and rat-gnawn canes, which had been thrown down from time to time. I accepted them, and with their juice I not only surprised my challengers with a sugar they acknowledged to be first-class and well crystallized, but 25 per cent. more than they got from the same definite quantity of juice of the best canes from the same field. I had, strange to say, but very little molasses.

Wherever by my process sugar is finished at a suitable temperature, the product, I am satisfied, will be found much more than these figures indicate, and the quality superior, being so near to purity.

I can have no doubt that my increased product surprises some people; I am, therefore tempted to elucidate my position by introducing another fact which I found exalted very high when I reached Demerara, about a year ago. A respected correspondent of one of the local newspapers furnished us with these figures as the outcome of a superior process to which the sugar on the estate which he controlled had been submitted. "301,700 galls. of juice at 9° B., afforded 256,743lbs. of sugar." Now a gallon of cane juice of 9° B. is supposed to contain 1·810lbs. of sugar. It follows that in those 301,700 galls. there were about 546,077lbs. of sugar. Of these we have here only 256,743lbs., leaving 289,334lbs. of sugar unaccounted for. That respected correspondent appears to have been quite contented with the serious loss indicated, as, like the eels, he was "used to it." He rather exulted over his success. If then I *avoid this serious loss*, by purity in the sugar, I apprehend my *increased sugar-product* is satisfactorily explained.

*South Hill Park, Hampstead, 20th Nov.*, 1873.

## SUGAR PRODUCTION, PAST AND PRESENT.

From the *Queenslander.*

In reply to many solicitations from personal friends, and to Mr. Warren's request in your columns to give my experience relative to trashed and untrashed cane, I have to state that, as the pioneer of sugar cultivation and manufacture in Queensland, my writings and experience were for a considerable time given freely to the public, under the idea (and backed by the expressed opinion of the Governor and many members of the Council and Assembly) that my services would be rewarded when proved successful.

During the past eleven years the press and the public have repeatedly acknowledged my services; but when my petition was presented to Parliament it was laid aside. But the Hon. L. Hope was granted 2000 acres of land—why, it would be difficult to state.

What has this to do with trashed and untrashed cane? you will say. Well, we shall see.

Trashing or non-trashing canes should be no more a matter of chance or uncertainty to a practical planter than any other of the numberless requirements that are necessary to know in this most important occupation. On this portion I propose to give some of my experience.

As a Barbadoes planter, I may state that such a custom is not followed, the term "trashing" there meaning covering the spaces between the stoles of the plant canes, at a certain stage of their growth, with the débris of the fields just reaped, which keeps down the weeds and retains the moisture during the dry months. In Barbadoes they only ratoon to a small extent. Now as this island is purely tropical, and with a regular north-east wind (trade) blowing over the land, highly charged with saline particles, the canes strip them naturally; and under such circumstances, to strip such canes would cause them to be forced ripe, and deposit on their rinds a white coating very difficult to deal with in the factory, causing the juice to scorch the taches before it reaches sugar density, depositing a crust on the taches requiring to be knocked off with a chisel. The temperature there averages, night and day, 80° in the shade, 90° and upwards in the sun; and it must be evident that certain practices suitable to such a climate can only apply in a few local spots in this colony, as I will prove.

My first experience here was at Cleveland, in 1862, as manager for the Hon. L. Hope, where, under circumstances of great difficulty, and during a time of severe drought, I succeeded in establishing the growth of a few acres of cane, principally with a view to making a nursery for plants. These grew and throve amazingly. Through that winter I watched the canes with the greatest care, not allowing a leaf to be touched, and they never changed their beautiful green color during all that winter. I then felt the battle was won, and Queensland was a sugar-producing colony. Then, as if by magic, up sprang a host of sugar-planters, and both my public writings and acts were criticised to such an extent as to destroy the confidence of my then employer. Mr. J. W. H. Strachan succeeded me at Cleveland, and immediately placed men to strip the canes; the result was, as stated by him in a paper read before "The Philosophical Society of Queensland," that the bad Bourbon cane, together with the red soil of Cleveland, produced plenty of molasses but very little sugar. Since then, Mr. Strachan is reported to have had heavy returns of sugar at his estate of Loganholme, owing, as we are informed, to leaving the cane untrashed. His returns, I may say, are the heaviest ever heard of.

Since leaving Cleveland my experience has extended over the following districts :—Caboolture, Pimpama, Maryborough, Bulimba, Logan, and Oxley—a period ranging over eleven years in Queensland; and to summarise my experience in trashing or stripping canes, its results are as follow :—

From early associations I confess to a predilection for untrashed canes, preferring to leave nature to fulfil her proper functions; but I have been obliged, by careful study and observation of the requirements of canes as at present cultivated in the low lying districts of Southern Queensland, where the temperature falls, during winter, from mid-day to midnight, 30°. This, in the majority of instances, so injures the inner leaflets as to prevent the continuance of proper growth in the cane, and causes the top to fall, and the eyes from the side to shoot, thus obliging the planter who is in a frost-bitten locality to prepare for his most bitter enemy, frost, by trashing his immature cane, so as to obtain all the light he can to force ripe his crop in season. On the Pearlwell estate, last season, the 12 months old ratoon cane, well trashed, but cut during frost, stood at 9°, and averaged 1½ tons of sugar per acre. This season, similar canes were only once trashed, and before they could receive the second trashing in June a severe gale occurred that laid the canes down in vast masses. Then a flood covered a portion of the low-lying land with two feet of water. The injured canes are now 6½° and 7° density, and will yield about ½ ton per acre.

But even in the low-lying districts, more especially on the coast not subject to frost, trashing might be omitted with safety. At present there are on this estate about 8 acres of Chigacca and Djoeng-djoeng cane planted in November, 1872, not trashed, as it is not intended to crush them this season. These canes are slightly whitened in their tops, but not injured by the frost. I simply, for experiment, trashed one or two stoles, and they shot out from every eye in a week during cold weather; but on the return of warm weather, when I think they are trashing themselves, I shall assist them to do so.

In conclusion let me add that, to carry on sugar estates successfully, it would be well for all concerned if capitalists would consult thorough practical planters, not only in trashing or non-trashing, but in all the various details requisite to constitute a well conducted sugar estate.

John Buhot.

## THE ECONOMICAL PRODUCTION OF SUGAR.

(*From "Iron," October* 18, 1873.)

Notwithstanding the complex ingenuity of the machinery employed in the sugar manufacture, the waste of saccharine matter in the process remains the opprobrium of modern mechanics and industrial chemistry. In the emphatic words of Professor Brande, the relation of the amount lost to that actually produced is enormous. Dr. Scoffern has proved that this loss is nearer two-thirds than one-half, a loss altogether without parallel in any other chemical art. And this deficiency remains untouched by the ingenious mechanical contrivances introduced from time to time, which, although they certainly improve the quality, only very slightly, if at all, increase the quantity of sugar, although indicating at all events that the shortcoming is in the ultimate processes, and in the chemical, rather than the mechanical manipulation of the cane and its products.

We recently referred to the former at some length, but the importance of the subject suggests that it be contemplated from another point of view, in order to ascertain whether the engineer deserves any and what share of the reproach which the common process tends to bring on all who practice and perpetuate it.

Of course the seasons vary, as "dry" or "wet" prevails, and correspondingly affect the yield of juice in quality and quantity. Hence the quantity of saccharine in the juice is not constant. To arrive at something definite, however, we may assume 9° B. to be an average density; but immediately our progress is impeded by the fact that caprice leads some men to use more, and others less juice of the same strength for a hogshead of sugar. The hogshead, too, is not a constant quantity on the same estate. A "statement" lies open before us, from which we accept "the gross weight of 50 hhds. as 978 cwt. 1 qr. 20lbs., after draining off some 89 galls. of molasses per hhd." After deducting for tare, we accept 19 cwt. to represent the weight of contents of a hogshead of sugar, say 2,128lbs. To obtain this quantity of sugar 2,500 gallons of cane juice are often used, and may be adopted for our argument, seeing that some use a greater, and others a less quantity of the same strength, say 9° B.

A gallon of cane juice at 9° B., contains 1·810lbs. of sugar; therefore 2,500 galls. contain 2,500 × 1·810=4,525lbs. of sugar; but we see the planter gets only 2,128lbs., and the difference between the sugar obtained and the contained sugar is 2,397lbs., which must represent the lost sugar, and is more than the planter has left to sell. Some have falsely attributed this immense loss to imperfect machinery, rather than to their own imperfect knowledge of the subject. Here we have taken the juice after it leaves the mill, therefore the mill has no further control over it. Planters have been thrown needlessly into confusion when told of 90 per cent. of moisture in the cane, a moisture that is falsely supposed to be available for juice, if they could but get it. To this end the engineer has been induced to strengthen every part of the mill, and increase the power of the engine. Still they fail to reduce the megass to a state of tinder, and, at the best, simply express an increased amount of gummy, resinous matters, found inside the rind of the cane, adding to the dregs without increasing the quantity of saccharine matter. In the presence of such conflicting facts, it must be desirable to ascertain where the loss complained of really originates.

The existence of one class of loss was admitted when we recognised the fact that each hogshead of sugar drained away its 89 galls. of molasses, representing about 426lbs. of sugar. Molasses is a sufficient index of the improper treatment of cane juice, seeing that this degraded product is not a natural but a manufactured product, the result of the imperfect process which all are anxious to improve.

We have seen that the planter loses 2397 lbs. of crystallized sugar by the common process, and of this only 426 lbs. were contained in the molasses. It is therefore clear that we shall have good reason to be satisfied with any process of manufacturing sugar frome cane-juice that can economically afford us a pure sugar, free from molasses. The immense loss of sugar evidently occurs after the mill has expressed the juice from the cane. Accident has not betrayed to us the seat of error, nor has chemistry revealed to us the new path by which we may avoid that error in practice, although we are taught to look in that direction with increasing confidence.

There are two extensive customers in the market—the refiner and the grocer. The former is already and abundantly satisfied; the latter is not so satisfactorily supplied with his "soft sugars," where the beet-sugar cannot compete with the cane-sugar, except by the help of the refiner, whose expenses must be covered by the consumer. We thus get a glance at the wide-spread interests which this intricate subject involves; nor is a single breakfast-table exempt from the consequences, and millions of money in every direction await the solution of the problem, to the consideration of which we shall probably return.

4, George-street, Edinburgh, Nov., 1873.

To the Editor of "Iron."

Sir,

All who are connected with the important but somewhat neglected cane sugar industries must feel grateful to you for the prominence you have given in your columns to information and discussions bearing on their interests, and I am led by your liberality in this respect to ask you to publish this letter at your convenience.

In your issue dated October 18th, I notice an interesting article on "The Economical Production of Sugar," calling attention to the great "waste of seccharine matter" which is generally to be found in the process of the manufacture of sugar from cane juice.

This loss is certainly, generally, very serious, but I am glad to think that—if we include all important producing fields—the relation of the amount lost to that actually produced is now by no means nearer two-thirds than one-half, as stated by Dr. S. Coffern. I must not, however, trespass on your space by questioning the figures on which you base your conclusions, as my present object is to show that you scarcely do inventors and engineers justice when you state that this deficiency remains untouched by the ingenious mechanical contrivances . . . which, although they certainly improve the quality, "only very slightly, if at all, increase the quantity of sugars . . ." The return you take of 19 cwt. of dry sugar from 2,500 gallons of cane juice, at 9° Beaume, is in my opinion a very poor one; and I also think you overstate the sugar contained in 1 gallon cane juice at 9° Beaume; which, taking the specific gravity at 1065, and the per centage of sugar at 16·5 (these figures are taken from a table by Dr. Dutrone), is only 1·76lb. per gallon, not 1·81, as you state it. According to another authority it would only be 1·73; and Dr. Icery states the *Crystallizable* sugar much lower than this, viz., at 1·59lb. per gallon of juice at 9° Beaume. In the instance you give, you estimate the loss at *more* than half of the crystallizable sugar present in the fresh juice; but from my own experience, in both the East and West Indies, I should say that on average estates, manufacturing Muscovado sugar, it would be more correctly stated at ⅜ to ½ at most, and that, on estates manufacturing vacuum pan sugar, it seldom averages.

I will now endeavour to show that there is at least one contrivance by the use of which this loss of saccharine matter is very much reduced, I might almost say entirely saved. In 1866 it was my privilege, on Belvidere Estate, Antigua, West Indies, to superintend the erection of the first Concretors established in the colonies, and the maufacture of the first concrete made on a commercial scale, under Mr. Alfred Fryer's patent. The entire crop of this estate was, in '67, manufactured into concrete, and, the system being then new, I was particularly anxious to obtain exhaustive and reliable results, and therefore kept a very complete series of records of the work done. To insure accuracy, all the measurements, weights, &c., were made and the record entered, either by myself or under my immediate supervision, and I, myself, attended to the works during all working hours throughout the entire season. I send you a table showing the principal results obtained, from which you will see the gradual improvement in the return towards the middle of the season, and the falling off as the season advanced. Had the crop been completed within the ordinary season the average density would have been considerably higher, and the weight of concrete per gallon proportionately greater, but taking the whole crop, closing on Sept. 19th, the following figures show the yield obtained:—

| | |
|---|---|
| Total juice received................ | 477,486 galls. |
| Average density .................... | 9°25 Beaume. |
| Nett weight of concrete shipped .... | 381·23 tons. |
| Pounds per gallon .................. | 1·788 |

Now on again consulting the table given by Dr. Dutrone, and taking the specific gravity given for juice at 9¼° Beaume, viz., 1067, and the proportion of sugar at 17 per cent., we have 1·8139 lbs. of saccharine matter present in the fresh juice, and therefore the loss was only ·0259 lbs. per gallon, or about 70. These weights were taken on the estate, but the total loss of weight during the voyage to England on the whole crop was only about 1 per cent. These results have since been maintained on the estate named, where the annual production has been much increased by the addition of new lands, and concrete only is manufactured. I could also refer you to reports of the working of Concretors in many other parts of the world, but prefer limiting myself to my own figures, as I can personally vouch for their accuracy. In conclusion, I may state that concrete, on the average, is nearly equal in value to good Muscovado sugar, in many cases it sells at higher rates, and it will, in my opinion, take a still higher place on the market list, when it is better known and more generally adopted by colonial manufacturers.

Apologising for the length of my communication,

Yours, &c.,

H. Ogilvie Bennett.

## SUGAR MACHINERY.

From "*Iron.*"

*(Continued from page* 582.)

We are not here concerned with the various matters which relate to the best method of growing and cultivation of the sugar-cane, as to which, however, it may be noted that planters of the sugar-cane have, of late years, been awakened to a sense of the advantage of a more careful and scientific attention to this point: the manufacture proper commences with the cut cane as brought to the factory. There are, of course, varieties in the quality of the cane itself, but these are minor points, which scarcely affect the general principles and mode of treatment. The object in view is to extract the sap and bring the sugar which it contains to a crystalline condition, freed from the fibrous and other substances, which are worthless. Much of the successful result of the mechanical treatment depends upon the manner in which the cane is cut, which should be done as close as possible to the ground, as the sweetest and purest juice is contained in the lower joints: the cutting is a manual operation and comprises the severance from the stool, lopping the leaves, and cutting off a sufficient portion of the top, which not only is much poorer in saccharine matter than the stem, but at the same time contains a much larger proportion of uncrystallizable sugar, the presence of which is detrimental; the tops are also used as cuttings for the propagation of the plant, which cannot, curiously enough, be grown satisfactorily from seed.

The juice of the cane, which contains the sugar, is, of course, contained in the sap-vessels forming the pith, which may be compared to a bundle of very fine, fragile tubes, very thin in substance, and made of fibrous matter or "cellulose." These sap-vessels are strengthened and protected by a hard outer ring, forming the cane itself, which, like the straw of corn, consists mainly of silicious and other mineral elements, concreted or cemented together by mucilaginous or gummy matter. Such being the nature of the cane-stalks, there are two modes of treatment whereby the sugar is obtained therefrom; namely, either by cutting the canes into pieces, and treatment of the slices by a washing or "diffusion process;" or by subjecting the canes to great pressure, for the purpose of expressing the juice. This latter method has been found to be as advantageous as any other, and it is the one most generally practised; and the tendency of recent years has been rather to improve the design and construction of the cane-mill, than to introduce or develope any new methods of treatment.

The juice, thus expressed, is of course mixed up with a considerable proportion of the minuter fibrous particles and gummy matters of which the stalk consists, and the subsequent stages of treatment are directed to the elimination of these extraneous matters. The first process of manufacture to which the juice is then submitted is that of defecation or clarification, which is effected in large shallow pans by the combined agencies of heat and lime; the heat being generated and applied by direct combustion in a suitable furnace, or by steam-heat, which is better and more preferable. The objects of this defecatory process are to effect the complete coagulation of the soluble albumenoid matter mingled with the juice, and its entire separation and removal, together with all other inorganic substances comprised therewith; to neutralise all free acids, of which the presence would be detrimental by causing, under the influences of heat, the rapid conversion of the crystallisable sugar into glucose; and to extract and separate all other injurious impurities which may be in mechanical or chemical combination with the juice: with the ultimate result of bringing about an approximation, in the clarified juice, to the condition and character of a mere aqueous sulution of sugar pure and simple. After clarification, the subsequent stages comprise the evaporation, concentration, and crystallization of the juice: as regards the evaporation and concentration, particular care is required to carry them into effect, at the lowest possible temperature, to avoid the injury which all sugar solutions receive from undue heat. For these

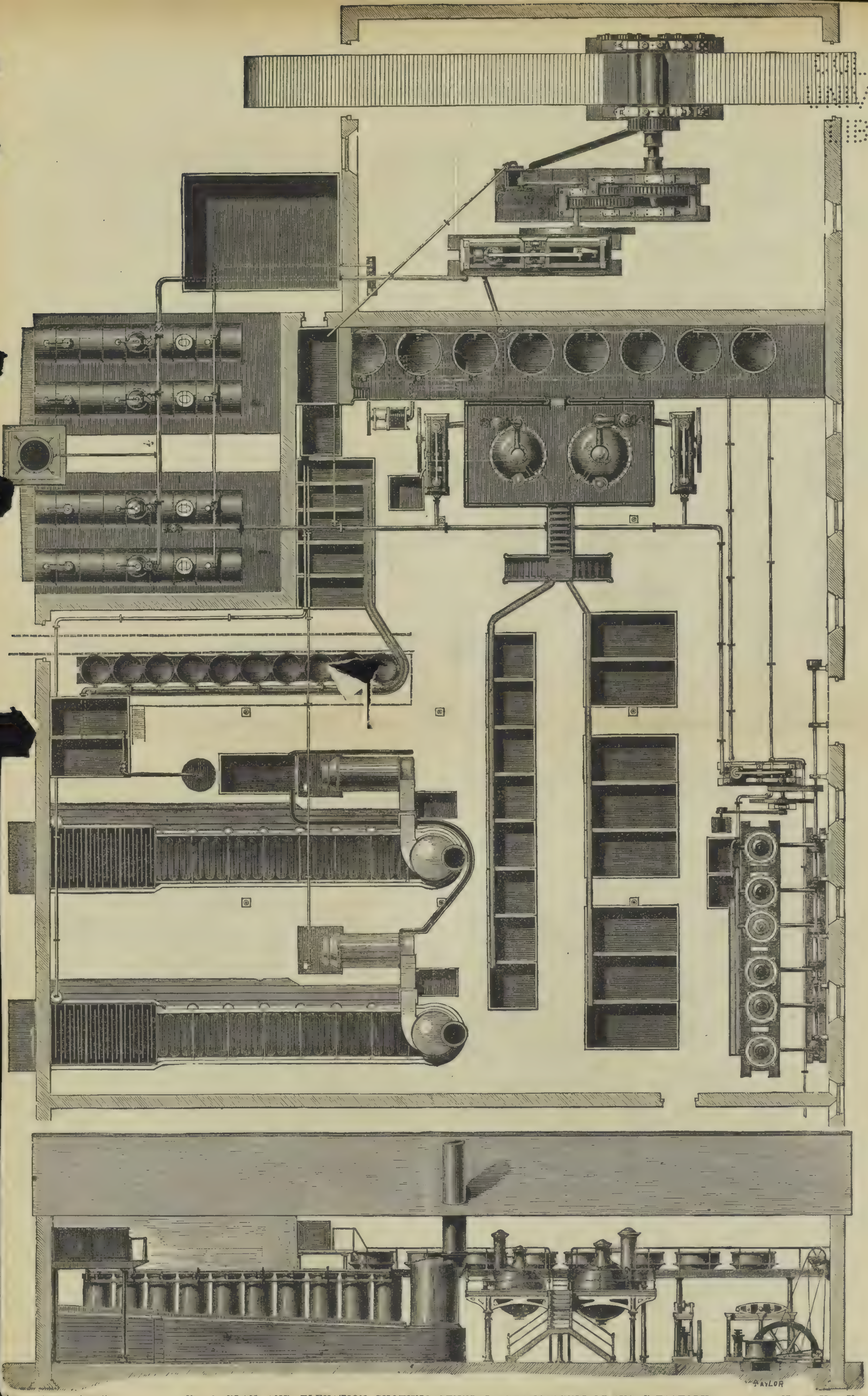

Fig. 2—PLAN AND ELEVATION, SHOWING GENERAL ARRANGEMENT OF SUGAR-FACTORY.

processes there are a great many different apparatus, ranging from the simple open pans over a furnace, which constitute a "Jamaica Train," and the shallow open coolers associated therewith, up to the more complicated and effective systems of Fryer's Concretor, Vacuum Pans, Triple-effect Pans, Wetzel Pans, &c., &c., according to the quality and degree of refining sought to be attained. There are also, of course, various other modifications in apparatus and method of treatment, for the more effectual attainment of the various results at the different stages; such, for instance as the Filter-press, Charcoal-filters, Centrifugal drying or draining machines, and so on.

A reference to our engraving, Fig. 2, will here suffice to explain the ordinary general arrangement of a sugar factory, as laid out and fitted up by Messrs. Manlove, Alliott, and Co., and there shown in plan and elevation or general view; and special descriptions of the different machines manufactured by them for the complete equipment thereof on the most modern and improved principles, will supply all the necessary details for the farther complete elucidation thereof. It would be impossible within anything like the space that we are enabled to devote to this subject—notwithstanding its interest—to give full illustrative drawings of all the machinery employed; whereon, indeed, a book might be written without exhausting the same. We have therefore selected, as examples the largest, most important, and modern machines, for larger engravings, Figs. 3 and 4, which show respectively plans and elevations of the steam-engine, gearing cane-mill, and of Fryer's Patent Concretor; and content ourselves with a brief technical description only, without illustrations, of the remaining machinery; as to which, however, we may remark that the scale of the general drawings of a modern sugar factory is sufficiently large to give a fair representation and idea of the apparatus in all its parts.

As will be seen from the plan the steam-boilers, in this case four in number, as well as the steam-engine and cane-mill, are located in separate buildings, external but adjacent to the main building of the sugar factory itself. Closely adjoining the crushing department we find the cistern into which the expressed juice is pumped up for farther treatment; and whence it may be fed into any of a series of eight clarifiers or defecators; with or without having been passed through the filter press, immediately adjacent. In front of the defecators are located duplicate vacuum pans, each of them operated by an independent steam-engine and air-pump, whence the juice is conveyed in pipes or canals to a set of shallow rectangular cooling pans, ranged down the middle of the factory. The clarifiers and defecators are raised upon an elevated platform, so that the power of gravitation may, as far as possible and convenient, be utilised in the removal of the juice therefrom. Cisterns are also provided, adjacent to the boiler-house, for the passage of the juice to the patent concretors, which are shown here in duplicate, with suitable furnaces and fire-grates accessible from the outside of the building, on the same side as the boiler-furnaces; and for the farther supply of the juice to the range of charcoal-filters, ten in number. On the opposite side of the factory, finally, are the series of six centrifugal machines, which complete the mechanical treatment of the juice and cane-sugar, and whence it is removed and suitably packed in hogsheads. The centrifugal machines, like the vacuum pans, are worked by an independent steam-engine. The ordinary sequence is, from the mill to the clarifiers, thence to the charcoal filters, and afterwards to the concretors; from the latter, possibly, a second time through the filters, to the vacuum pans, and coolers, finishing with the centrifugals.

These being the general arrangements and chief features of the process and mode of treatment in outline, we have now to fill up the details by more minute description of the various stages and operations, and of the mechanical appliances connected therewith; commencing with the crushing of the cane. It will be seen that the cane-mill is provided with two travelling belts, placed one on each side, of which the one is the cane-carrier, which feeds the canes to the crushing rollers, and the other is the megass-carrier, similarly used to remove the crushed cane as it issues from the rolls. These carriers need no particular description, as their construction is familiar to all mechanicians; the feeder, or endless platform, made of laths, is carried round two revolving drum-wheels, actuated by suitable connections with the train-gear; and it is on an ascending incline, the canes being carefully and regularly placed on the foot thereof, outside the building, in the yard where the cane is brought to the mill; and thence the carrier in its motion elevates the stems, and delivers them on to a feed-table sloping downwards to the rolls. The cane-mill itself—which, although considerably improved in detail and construction, is by no means a modern apparatus—consists essentially of a strong frame-work, resting on a bed or foundation plate, and carrying suitable bearings for three large and heavy rollers, of which two are set on the same level, parallel to each other, but a little distance apart, and the third is placed just above and between them, revolving in close contact, or nearly so, with both. The canes, being delivered from the feed-table in between the first lower roller and the intermediate upper one, are crushed in their passage between them, and then encounter a stop or guide, called a trash-turner, which causes them to be directed in between the intermediate upper roller and the second lower roller; whence issuing, the crushed canes are removed by the second or megass-carrier, situated at the lowest level to receive the same, for disposal as manure, or to be dried for use as fuel. As regards the operation and connection of the various parts, we may note that the speeds of the cane-carrier, the rolling-mill, and the megass-carrier, are suitably differentiated, so as to avoid glutting or choking the rolls by the stems being fed too rapidly, or the crushed cane being removed too slowly; for which purpose the megass-carrier is speeded slightly faster than the rolls, and the rolls than the cane-carrier. The cane-carrier should be of sufficient length to allow the stacking of the canes alongside of it, as brought to the mill, and to ensure the avoidance of haste and irregularity in laying the canes thereon—not less than 50 or 60 feet—and arrangements made for throwing it in and out of gear, as may be required.

*(To be continued.)*

# A METHOD OF SUGAR DETERMINATION BY MEANS OF IRON.

By M. Edmont Riffard.

*From the "Journal des Fabricants de Sucre."*

Tartaric acid, malic acid, citric acid, albumin, and sugar are known to hinder the precipitation of iron in alkaline solutions.

A solution of iron peroxide in an acid liquid, free from sugar, is precipitated as soon as the solution is neutralized by ammonia; but if the iron and sugar are together in certain amounts, or if the sugar be in excess, there is obtained on saturation by ammonia, a sucro-ferrate of ammonia, a compound of a bright red colour, which is soluble in the solution, provided no alkaline-earth metal is present.

Having studied, as one of M. Jouette's students, his method of determining tartaric acid, I have attempted to extend this method to the determination of sugar, and have found that it is applicable to this also.

It is important, however, to note two distinctions according to the condition of the iron per-oxide in the solution.

If it is in the yet imperfectly known condition of modified peroxide, obtained by adding a little hydrochloric acid to a solution of crystallized perchloride of iron, 100 milligrammes of iron require, so as to remain in solution in the presence of ammonia, 3·710 grammes sugar.

If, on the contrary, the solution be prepared by simply dissolving pure crystallized perchloride of iron, without the addition of acid, 100 milligrammes of iron only require 2·587 grammes of sugar to keep them in solution. If there is added to this solution, for every 100 milligrammes of iron, 2·587 of sugar or a larger quantity, then ammonia in excess, in order to render the solution nearly alkaline, there is obtained, after brisk agitation, a perfectly clear and continuous red liquid.

If, on the contrary, 2·580 grammes, or a less quantity, of sugar be added to 100 milligrammes of iron, then ammonia in excess, the solution, formerly turbid, immediately deposits the characteristic precipitate of peroxide of iron.

The soluble compound produced in the case of an amount of sugar equal to, or more than, $\frac{2{\cdot}587}{0{\cdot}100}$ is insoluble in alcohol and ether; but is destroyed by heat or by calcareous salts, and its precipitation is accelerated by the addition of ammonia salts in excess.

However, experience has proved that the error which would occur from the precipitation produced in clear solutions by the hydrochlorate of ammonia, formed in the experiment, would be through negligence.

In practice, 25·870 grammes, or 37·100 grammes, should be dissolved according to the condition of the iron solution of sugar to be analyzed, a few drops of oxalate of ammonia should then be added to precipitate the lime; it should then be filtered and the volume made up to 250 cubic centimetres; then take 25 cubic centimetres, and, considering $n$ as the number of hundredths of pure sugar contained in the sample, add $n$ hundredths of iron, which should remain in solution.

We will thus have, in two experiments the different results, as follows:—

With $n$ milligrammes of iron: clear solution.
,, $n+1$ ,, ,, a precipitate.

$n$ being the number of hundredths of sugar which the sample contains.

The method is applicable to the titration of beetroots, juice from sugar refineries at different stages of manufacture, molasses, &c.

The action of inverted sugar is greater than that of crystallizable sugar. 0·357 grammes of crystallizable sugar inverted by hydrochloric acid is sufficient to maintain 100 milligrammes of iron, in the condition of modified peroxide, in solution.

But as certain sugars, principally exotic, contain inverted sugar, which might falsify the results, I completely steer clear of this source of error, by shaking in the cold the sugar to be titrated, with alcohol of 95°, and filtering the solution. The inverted sugar and some organic acids are dissolved, whilst the sugar remains undissolved.

The method indicated, and which I have often applied successfully to many sugar analyses, has always given results similar to saccharimetrical results.

## THE LOGAN AND ALBERT.

The correspondent of the *Queenslander* thus writes to that paper—

"I started on the 20th instant to see and report upon what is generally called the Logan district, thereby meaning the whole of that portion of East Moreton which includes the watershed of the Logan River, and the country farther south, up to the boundary of the colony. Politically speaking, the Logan electoral district has not much to do with the river of that name, excepting that the residents on the right bank, from Jimboomba to the mouth of the river, are comprised within the electorate. Higher up, the Logan watershed is in the Fassifern district.

The first place where I saw any cultivation was at the Eight-mile Plains, which by the road is over ten miles from town. Agriculture is not in a very flourishing condition here, although the place was one of the early selected reserves. The crops are mostly maize, with some cotton. Two miles beyond the Eight-mile Plains Hotel is another known as Underwood's. The roads so far—as is usual where they are found—follow the leading barren ridges, which are naturally best suited for traffic in wet seasons. The cultivated lands lie back out of sight of the traveller who keeps the road. I now had the choice of three roads—one to the Upper Logan by Drynan's Ferry, one by Waterford, and the lower one by way of Loganholm. Travelling by the latter, however, being closed to horsemen, owing to the punt by which the river was crossed having been swept away during the recent floods, I chose the middle road, being desirous of reaching Beenleigh, which is the chief township of the district and the centre of the sugar-growing and manufacturing of the Logan and Albert.

The village of Waterford is between eight and nine miles from the Plains, by a rather dull road, the view being confined to a few yards from the track, owing to a thick growth of small trees, including oaks, banksias, and others. The place contains a couple of public houses, one of which is the Post office, and a lock up. On the other side of the river is a school-house, but it has not been used for five months. There is no residence for a teacher, nor any sign of erecting one, although I was told that some time back the inhabitants of the neighbourhood subscribed for the purpose. Here the first plantation and sugar mill is found, being Tygum, the property of Mr. Jordan. It contains 350 acres of land of fair quality, 60 of which are under sugar. There is also a mill on the river bank, at which Mr. Jordan told me he expected to manufacture a hundred tons of sugar this season, or about the same as last year. Of course, this yield is not from Tygum alone, as most of the farmers in the neighbourhood crush their cane there. A short description of the works and the process employed may save repetition when I come to refer to the establishments which I subsequently visited, although the mill was not at work, it being intended to commence operations on July 28.

The mainspring of the works is a very neat little steam-engine of fifteen horse power. By it the cane, received in punts from places along the river, is drawn in a truck along a tramway up the steep incline of the river bank, when it arrives on the platform of one of Avery's weighing machines, capable of weighing four tons. The cane is then passed through three cast-iron rollers, eighteen inches in diameter and three feet long. The expressed juice flows into clarifiers, and, after settling, passes from one to the other of the battery pans, where it is kept boiling. These, at Tygum, are five in number, and the boiling liquor, having been skimmed, is ladled from No. 1 to No. 2, and so on until it reaches the last, which is called the "teach." It is then removed into a "Baur" pan, which is a revolving cylinder heated by steam, and thence into large coolers, where it remains a day or two. The juice has now become sugar, mixed with molasses, and to remove the molasses the whole is placed in a centrifugal. This consists of a drum, three feet in diameter, made of finely perforated copper, which revolves at immense speed within an iron case. By centrifugal force all the liquid portion of the mass flies off through the holes, and the dry sugar is left behind adhering to the inside of the drum. With regard to other details and improved modes of procedure, I shall have more to say further on; but the foregoing gives a general idea of the process. I was told that at Tygum the mill could crush in eight working hours nine clarifiers full of juice, and the works were capable of turning out two tons of sugar per day. For conveniency, the two centrifugals have each their separate small engine to drive them, although, if necessary, the required force might be given by the large engine. The boiling house is not quite so compactly arranged as at other places, and square boiling pans are used instead of round, which appear to be better for the purpose. During the crushing season, about forty white men are employed in different capacities. Several carts were removing a great heap of steaming manure, the refuse left after crushing the cane, which had been rotting for the last two years. This is to be ploughed into the land as the cane is cut, and thus at least a portion of the constituents of the plant is returned to the soil. A small piece of low lying ground near the river has been damaged by the frost; but the same has been the case with this patch every year. The rest of Mr. Jordan's cane looked healthy.

Higher up the river there is a horse-mill, which, not being at work, I did not visit. Below Tygum, the next mill down the Logan is that of Messrs. Fryar and Strahan, about a mile and a-half from Beenleigh. The interval along either side of the river is occupied principally by small farmers, all of whom grow cane. Crossing the river by a punt, I called at Mr. John Hinchcliffe's plantation. He has about thirty acres under cane, and intends to crush twenty-five acres at a new mill being erected at the junction of the Logan and the Albert. There were seven Polynesians employed on the ground, and about a dozen more will be engaged for cutting the cane. Some of the plants on low ground have been affected by frost, and Mr. Hinchcliffe is of opinion that this always will be the case. He has tried draining, and found that it made no appreciable difference. He has been a great experimenter for several years past, and at the last agricultural show at Beenleigh obtained a prize for exhibiting twenty-six varieties of cane. He has now thirty-three varieties growing, and still hesitates in pronouncing a decided opinion upon which would be most generally useful. What answered last year has not done so well this year. Ribbon is good for scrub lands, and Bourbon for forest ground; but as regards other varieties there is great difference of opinion; nor is there yet any general agreement as to all the details of cultivation, time of cutting, &c. Mr. Hinchcliffe is also growing rice, which appears to answer well, and he is confident that it will pay. He got a very heavy crop off a small strip of ground, and is saving it for seed, a sample of which will be sent to the forthcoming show at Brisbane. There were two crops during the season, but the second was much inferior to the first. There is a good garden attached to the plantation, from which great quantities of oranges, lemons, citrons, and other fruits have been obtained, and where experiments are being made to ascertain what new plants can be grown with profit.

The distance from Waterford to Beenleigh is five miles, over a rather hilly country, the road following leading ridges where possible. I added, however, four miles to the distance by striking off towards the Logan. It was a fine sight to see stretching along the river banks for miles, over what was once dense scrub or forest land, a broad belt of green, indicating the presence of sugar cane, for at this time of the year maize is in the sere and yellow leaf, and little is left of the cotton plant except the dark stalks. In this part the cane has not suffered from frost, except where the ground is low. At a place called Sherwood, there is a neat Wesleyan chapel, and the minister rode in with me to the township.

Beenleigh, which is the metropolis of the sugar district of East Moreton south of the Brisbane, is situated between the Logan and Albert rivers, at a distance of about a mile and a-half from each. In the maps, it is inaccurately placed on the latter river, on the originally intended site for the township. It is not badly placed, and there is here the junction of five roads leading to the principal parts of the district, both up and down the Albert and Logan, and in the direction of the Coomera and Nerang rivers, as well as of the watercourses that flow into the Pacific, farther south, up to the boundary of the colony. The buildings are all of wood, but being neatly constructed and nearly all painted, they present a better appearance than those of other bush towns which I have seen. The branch of the Queensland National Bank is a rather attractive two-storied erection. The counter in the office is made of the tulip wood found in the district, which, from the beauty of its appearance, would be highly valued in England for veneering, or solid furniture of an expensive description. Another building having two stories is the Beenleigh Hotel, the property of Mr. Betz, formerly of the School of Arts Hotel, Brisbane. Besides a second hotel there are two large stores, one of which, that of Messrs. Pietzcker and Co., is presided over by our old friend Mr. Von Kosa, who is also postmaster. The other store, which is the property of Mr. Savage, has attached to it a very pretty and well-arranged flower garden, which is more than one would expect to meet with in so young a place. Another surprise was to find a Good Templars' Hall, but I looked in vain for a church. The Government buildings consist of a court-house, lock-up, and police quarters, and a school-house with teacher's residence—all of which are constructed in a similar neat style. The local trade directory—were one published—would contain the names of a baker, a butcher, a carpenter and building contractor, who is also a boat builder, a tinsmith, and plumber, a saddler and harness maker, and a couple of smiths. There is a demand for house and business accommodation, and several new buildings are in course of erection.

The township of Beenleigh was christened by the Government Surveyor after the adjoining property of Messrs. Davey and Gooding; and the latter was called after a place in South Devon, of which pleasant part of England Mr. Davey is a native. There are about 100 acres under cane, and 30 acres more are being cleared to try the effect of keeping a portion of the scrub standing for the purpose of sheltering the plants. This was the first place at which I saw Polynesian labour being used to any great extent, there being twenty-five islanders employed. Of these, four had completed a former period of service, and after visiting their homes had returned to Queensland. The other man, who was stationed at the "teach" pan, where one of the most important operations in sugar boiling is conducted, fulfilled his engagement to Messrs. Davey and Gooding, went down to Brisbane, and spent his money in purchasing articles to be sent to his mother, after which he returned to his former employers. These five men are rated as skilled laborers, and receive 10s. a week and rations. The whole of the islanders appeared to be well fed and in good spirits. They talked and laughed, and played practical jokes upon one another, without any appearance of being cowed by the presence of their employers, or abashed by the dignified demeanor of the strange visitor. Subsequent experience has proved to me that these people are, as a rule, treated kindly by their masters—indeed, it would be impossible to manage them in any other way; for it has been found that if spoken to harshly they sulk and nothing will induce them to work. There can be no doubt but that immigration to Queensland is a good thing for the Polynesians. Whether it is equally good for the general interests of the colony is a question upon which I am not called upon, in my present capacity as a reporter, to express an opinion. I have seen them on Sunday riding good horses, and dressed after the fashion of bush dandyism. I am told, upon unquestionable authority, that several of them have deposits at interest in the National Bank for amounts ranging from £20 to £60, and others are depositors in the Government Savings Bank. As I proceed in writing out from my notebook I shall have occasion to report the different ideas that are expressed by planters upon the subject of Polynesian labor.

Mr. Davey is a practical agriculturist. His cane looks healthy, and has been affected by frost only in one of the hollows, and that to no injurious extent. His opinion is that the Chigaca variety stands the frost better than any other he has grown. In clearing away the scrub, one remarkable tree has been left standing in an opening in the cane fields. It is what is popularly known as a "crow's ash," and a thick vine has closely twined round it, looking as though a huge boa constrictor was enfolding the trunk and lying in wait for its prey. At the time of my visit the mill was crushing 20 acres of ribbon cane for Mr. Hausmann. It is capable of turning out, with an average density of juice, a ton and a quarter of sugar per day. Last year the average returns was from seven to eight tons per week. The most noticeable differences between this mill and that at Tygum are, that in the former the steam is supplied by a multitubular boiler, which, although more expensive at first, causes a saving of fuel and prevents the waste of heat; and also that the pans of the boiling battery are all circular.

The plantation to which I have just referred is situate on the Albert river, about a mile and a half from the township. The next which I will notice is on the left bank of the Logan, and about the same distance from Beenleigh. On arriving at the river I found a large store belonging to Mr. M'Millan, evidently doing a considerable trade, for it was crammed with goods, and several persons were transacting business with the proprietor. Up and down the river bank, as far as the eye could reach, were small farms, principally belonging to Germans, in every one of which there were green patches of sugar-cane, the dark intervals showing where the cotton and maize crops had been. At this place the river is of considerable breadth — wider than any part of the Bremer — and the punt, as before mentioned, was washed away by the recent flood, to regions unknown. I left my horse behind and crossed over in a ferry-boat to Loganholme, the plantation of Messrs. Fryar and Strachan, and having had the good fortune of finding the latter gentleman at home, was shown by him about the place, and received all the information I required. The property consists of 640 acres, about 150 of which are under cane. A considerable proportion of this has been let to small farmers upon clearing leases, but which Mr. Strachan explained to be equal to working on shares, the farmers receiving every assistance they required in the way of ploughing, loan of tools, &c. He is quite opposed to Polynesian labor, and says that he cannot afford to employ it all the year through. Having a considerable number of small farmers on the ground, he can always obtain from them what assistance he requires, and it is furnished by experienced and intelligent men. One reason why he does not see any occasion for having South Sea Islanders is that he does not believe the necessity for "trashing." I may explain that this term, which is used by writers in this journal as if everyone must know what it means, simply signifies stripping off the lower and older leaves, and thus exposing the body of the cane to the full influence of light and air and the heat of the sun. Mr. Strachan prefers to leave Nature to herself. He admits that it might be as well to trash twelve months' cane, in order to keep the plants clear; but he does not consider it would be worth while to do so unless he could get the work done very cheaply. The cane on the Loganholm plantation has suffered a good deal from frost this season—much more so than last year. This is remarkable, for the general expression of opinion in the district is to the effect that the frost of last year, which continued until the middle of August, was much more injurious than what we have had, so far, in the present year. Mr. Strachan explains that from the peculiar position of the Loganholme plantation, the prevailing winds of this exceptional season have had more effect than would otherwise have been the case. He stated that the "Traboc" description of cane had not been touched by frost, and he considered it best to plant on low ground and clay land. Last year, in places where the Bourbon and ribbon varieties were killed, this description of cane was scarcely touched. I was shown a large quantity of "megass" manure—the refuse after crushing the cane—which had been left for three years in a low, damp position, and had become thoroughly decomposed. It was not steaming, like that which I saw at Tygum, but fermentation had quite ceased, and it formed a rich black compost. On this subject of megass manure, also, there is a diversity of opinion amongst the planters, as will be seen further on.

In the present infancy of the industry, the theories with regard to sugar growing are many and various; but there can be but one opinion of the engineering ability displayed by Mr. Strachan in the construction of the mill belonging to his firm. It is utilised all the year round in sawing timber, as when I saw it; in ginning cotton during the proper season, and in the manufacture of sugar, which will be begun in a few days from the time I write. The mill is not different in principle from others that have been described, but is capable of turning out 10 tons a week. The boiler is a tubular one, and, after steam is up, the fire is allowed to go out, and the necessary heat supplied by the furnace under the boiling pans. This arrangement not only saves fuel, but is said also to keep up a better heat in boiling than by following the usual course. One of the mechanical contrivances which must strike one who is unaccustomed to such matters is an application of Morton's patent water lifter. Simply by turning on the spare steam into a peculiarly constructed pipe during the dinner hour, and at night after crushing is over, the condensation of the vapour draws up a supply of 500 gallons of water per hour for the use of the works, to a height of 17 feet, from a creek 200 yards distant. The boiler is also supplied with an apparatus upon a somewhat similar principle, called "Gifford's injector;" but in this case the water is forced up by steam, instead of being drawn up by suction caused by condensation. Below Loganholme, and between there and the junction of the Albert, there are two sugar mills of a superior description being erected, which I hope to see when at work. In the meantime, let us cross the Albert by a punt close to Messrs. Davy and Gooding's plantation, and we arrive at the small township of Yatala. There is a store and post-office here; also a butcher, a saddler, a smith, and a well-conducted hotel upon a more extensive scale than could have been expected in so small a place. One of the larger rooms is used for public meetings, balls, and concerts, by the residents on both sides of the river. From what I could hear, however, almost every social movement in this neighbourhood and in Beenleigh is the cause of much bickering and unconcealed ill-feeling. The people seem to think that this unfortunate state of affairs is peculiar to the locality, but I have found things neither better nor worse in every new settlement of the four colonies which I have visited. By-and-bye, as population increases, society will settle down, and all classes will work more smoothly together. Yatala is also possessed of a building intended for a Freemasons' Hall; but although finished, it has never yet been opened, on account of some misunderstanding between the proprietors and the contractor. With the exception of this drawback, the brethren of the mystic tie in this district have displayed considerable forethought, for they have managed to get a hall built before a single lodge has been formed.

The Yatala plantation is close by the village, but I was unable to see the manager and ascertain its size. The more I walk through the cane fields, the more I become convinced that the plant requires thorough cultivation; and this can be done more cheaply and effectively by the plough or horse-hoe than by hand. The cane mill and boiling house differed in no particular respect from others I had seen; but every important part of the operation was conducted by a white man, the islanders being only employed in unskilled labor. Mr. Gartside had charge of the mill, and appeared to be very successful as a boiler. The megass passed out of the rollers in a perfectly dry state, and scarcely a trace of sugar could be tasted in chewing it—which is everything but the case at some establishments. The cane passing through the mill had been bought from farmers in the neighbourhood. The sugar house was not very well ventilated, and I could not see more than a yard or two around me, owing to the dense vapour which combined on the roof and fell upon me in a syrupy shower bath.

Lower down the Albert the soil is of the richest description for sugar land, with a fine growth of grass for stock. I visited two of the principal plantations on the right bank. The first was that of Mr. Peter Betz, who has 430 acres on the slope of Mount Stapylton and along the flats at its foot. There are sixteen acres under sugar and eighteen under corn, but twelve acres of the latter will be planted with cane in the approaching season. Nothing could be more luxuriant in appearance than the sugar-cane, and scarcely a trace of frost could be detected. This is attributable to the splendid soil, the sheltered position, and the land being well and easily worked. Mr. Betz formerly employed Polynesians, but now has only six or seven Europeans, English and German, engaged in clearing fresh land.

Adjoining this property is a small farm belonging to two Germans, who grow a little cane, and manufacture a good quantity of arrowroot during the season.

Lower down the Albert, beginning on the opposite side of the mountain, and, with a frontage of two or three miles, following the river to below its junction with the Logan, is the fine plantation of Mr. Witty, of Brisbane. It is called "Yellow-wood," which is the name commonly given to the Mount Stapylton of the maps. This estate consists of about 800 acres, of which 80 are under cane, and clearing is continually going on to admit of more being planted. If I remember rightly, there are about fifteen Polynesians employed here, the only white men being Mr. Spencer, the manager, and the ploughman, who, when not employed at his special duty, acts as overseer. The islanders had just been grubbing some ten or a dozen acres of forest land, and were piling together the timber, some of which was of considerable size, for the purpose of burning it. There was a great deal of talking and laughing going on amongst them; but I have been told, not by one only, but by every planter who employs these people, that, although slow, they are sure and steady, and keep on at the same rate of work from morning until night, so long as they know what they have to do, whether looked after or not. The cane seemed healthy, with very little sign of frost, except that in the low ground the tips of the upper leaves were slightly touched. Mr. Witty intends to erect a mill next season, and to build a house for himself on a picturesque spot on the slope of the mountain, from which a view can be obtained over the whole plantation. There is a garden attached to Mr. Spencer's residence, which provides abundance of fruit. The soil consists of rich fluviatile deposits, and would grow any vegetables or plants that do not require severe frost for their proper development. On both sides of Mount Stapylton there are permanent springs of water. The property just referred to surrounds the township of Alberton, which consists of a store, one or two huts, and a German Lutheran Church. The plantation of the Rev. Mr. Hausmann is on the left bank of the river, and he has abundance of material for forming a good congregation, the country along the Logan being for several miles above, and I believe below Alberton, occupied by small farmers, who are nearly all Germans.

Let us now return, and crossing by the punt at Yatala, follow the Albert up the left bank. The first place we come to is the Noyea plantation, belonging to Messrs. Gartside, Muir, and Black. It has a not undeserved reputation in the district, both from its extent and the superior way in which it is cultivated. It consists of 600 acres, nearly all forest land, almost the whole of which is under Bourbon cane. Twenty three islanders are employed, and a few Europeans as skilled laborers. The ground is beautifully clean, and the cane looks as healthy as can be. A few acres on the low ground are slightly affected by frost, and this cane is to be crushed at once; and about forty acres of ratoons of the sixth year from planting will be ploughed out and replaced by fresh plants. There is a large mill on the ground, which was not working on the day of my visit, owing to the breakage of a part of the machinery which had to be repaired. The establishment is worked by a 20-horse power engine, and is upon the usual principle. I saw one of the partners, Mr. Gartside (brother of the gentleman of the same name whom I saw at Yatala), and he expressed himself strongly in favor of trashing the cane. The sugar in the coolers resembles that of Yatala, already referred to, in being remarkably dry and hard on the surface. The two plantations next higher up the river presented some novel features different from those I had before seen, and deserve a full notice, which I shall have to defer until my next letter.

## ON BEET-ROOT AND BEET-ROOT SUGAR.

*(From a Pamphlet by E. F. Cull, of The Canada Company, Toronto.)*

(*Continued from page* 595.)

The end of the pipe away from the stove must be fixed by a flexible tube to the hole in the bellows, which is intended to draw in the air, then by working the bellows, the air will be drawn through the charcoal fire, and be turned into carbonic acid gas; this gas is then forced into the juice, which it carbonates. You can use either charcoal or anthracite coal, as the latter affords carbonic acid gas as well as the former, and is better in some respects, where it can be had, for the dust and ashes of the anthracite does not contain potash, or other salts that would be mischievous to the syrup, and any dust that gets in can readily be strained out.

The syrup should be cold, if you have means of keeping down the froth which will be raised by means of the bubbling of the gas through it from the bellows; but if you have no such means, just warm enough to keep a *little* grease, such as butter, melted on the surface of the juice; the syrup or juice won't froth with the grease, but the grease does not improve the sugar.

You must keep the bellows driving the gas from the burning charcoal, or anthracite, until you see that the chalk or lime is all set free, and settles well, then take some of the fine clear liquor which has been carbonated, and put it in a glass, and blow through it with a reed or straw from your breath, for five minutes. If it get thick, you have not carbonated enough. As soon as you are satisfied that it has been thoroughly carbonated, strain it through a filter cloth, in the same manner as at first; but the cloth must first be well washed and perfectly clean, and the syrup or juice will then be fit to boil down into sugar. If you don't do it right the first time, you must try it again, but the lime must be all out of it before you evaporate it down for sugar.

You may then boil the juice down to a proper consistency, and, if all has been well done, it will crystallize into brown crude sugar in about eight days; but the syrup during this time must be kept about as warm as fresh cow milk. During the process of evaporation, the syrup should be strained through a filter bag several times.

When ready to set by to crystallize, the syrup must be so thick that when a drop is parted between the finger and thumb, it ought to break across the thread, and the ends turn a little; it must be perfectly bright and clear, though the colour may be dark. It had better, however, be a little too thin than too thick, as the thin syrup will get thicker while set by to crystallize, and it is believed that in that shape it makes larger crystals.

Now, the difficulty with beet sugar has always been the crystallization, and the trouble has been what the Germans and French call "slime sugar;" but if the foregoing rules are *exactly* followed, there will be no slime sugar, or treacle—scarcely enough to enable you to get off that portion of the syrup which contains the salts, and which must be got out from the mass with the turbine. If you proceed to the second operation, bear these few rules constantly in mind. In the first operation, when you add the milk of lime to the juice to clear it:—

1st. Never keep the lime in contact with the *hot juice a minute longer than you can help it;* the lime cannot be dispensed with to clear the juice, but its action on the hot juice produces more or less of slime sugar.

2nd. Do not agitate the juice with the lime in it, more than enough to mix, or you will spoil your filtration; the larger the flakes remain in the juice the better it will filter.

3rd. Never carbonate at any other than a low cow milk heat. If you carbonate hot, as most of the books tell you, you will make slime sugar.

Of course, throughout all the process of boiling, heating, and evaporation, you must be extremely careful neither to burn nor even brown the syrup. The syrup will always be highly coloured, but if it has not been burned, all the colour comes out without waste in the after processes; and if the process of evaporation be conducted in the best manner, the sugar which crystallizes out of the coloured syrup will be nearly if not quite white. The burned sugar can never be recovered.

The above is as far as the writer would recommend any farmer, or any but a sugar refiner, to carry the process. If the foregoing instructions are well carried out, the thick syrup produced is just in the proper state for the refiner,—and it will always command a reasonably good and remunerative price.

The foregoing instructions are the result of *actual experiment*, and may be relied on as the result and experience of two years' continual experiments on a working scale.

### REFINING.

The foregoing is as far as, in the writer's opinion, any farmer or small manufacturer ought to go in the preparation of an article for the manufacture of beet root sugar. There is nothing in the foregoing processes which a person of ordinary intelligence and information cannot do. The process is a simple one, and the result an article of a certain commercial value.

Refiners of sugar want to get their crude materials with as little done to them by people who do not understand refining as possible, as they have certain processes to go through, and they do not, of course, want to have to amend the blunders of other persons; and any attempt at partial refining, or the use of chemicals by the producer, is quite as likely to be wrong as right for the after processes. But, as every one wants to know something more about the method of refining the crude material before described, and as many persons are adapted to follow out such after processes with success, I shall now proceed to describe in general terms the process of sugar refining, with this caution, that I only go into the matter generally, and that no one should go into much of an outlay in the refinery process until he has, by experiment, made himself thoroughly master of the subject. It is one that admits of experiment, and success (so far as the result of refining) can be attained on the small as well as on the large scale; that is, any man, after studying the subject, can refine one pound or ten pounds of the before-described crude material into pure sugar, but he will not be able to make use of the refuse, nor to do things in the economical manner in which they are done in the large refineries; he must not expect to be able to conduct the business on a profitable scale. Nevertheless, it may suit a number of persons who may prefer to manufacture at home, at no profit, rather than purchase, even if they do so at what to the manufacturer would be a positive loss. I shall proceed to give such instructions as will enable those wishing to do so, to carry out the process of preparing beet root sugar, and converting the crude article into such a sweet as will be consumable in a family.

The decolorizing of the syrup, and the destruction of the strong beety flavour, before spoken of, are accomplished entirely by the use of animal charcoal, which consists of burnt bones, prepared in a particular manner, and brought to such a state that the syrup will only percolate through the vessel which contains the bone charcoal at a slow rate. The bone charcoal is put in tall narrow vessels made of copper or boiler plate, often in some of the larger refineries as much as from 20 to 30 feet high, and of a breadth of from three to four feet. In other refineries the dimensions are different. In the beet sugar factories in France and Germany, the size of the bone black filters is generally 12 to 15 feet high and a diameter of about 40 inches. There are several of these in a factory, and they are each so arranged that juice, syrup, hot water, cold water, and steam can be severally applied as wanted. There are tight covers, held in their places with screws, to fill and to empty the filters, and also means of applying chemical substances and gases to the bone black, as it becomes saturated with impurities and requires to be cleansed.

After these filters have been worked but comparatively a short time, they lose their power of destroying the colour and peculiar flavours of the syrup or juice. The filters have then to be emptied, and the bone black heated to a dull red, in closed iron vessels, so as to burn out the impurities which have destroyed its peculiar powers. The bone black is then quenched and cooled, out of contact with the air, in properly prepared machines, and the filters are again refilled, to be again emptied, and the coal reburned as soon as it becomes exhausted.

The burning kone of charcoal, and also the revivification of the bone black when it has been used, are very offensive operations, so much so, that they are not allowed to be carried on in the city of London, which *was* the great centre of sugar refining; and the cost of burning and re-burning—carting into and out of the city of London, has been so great as to seriously injure the trade, which has been principally removed to Glasgow, where the civic authorities are less sensitive to smells, and more sensitive to commercial prosperity.

It is this bone charcoal business that will always prevent the refining, to any great extent, of beet root sugar, by the farmer and small manufacturer. The amount of capital invested in the bone black and the necessary machinery and utensils, are enormous; and the business must be continuous, and extended all the year round.

Another reason why the refining of sugar cannot be profitably carried on by any one but a person largely in the business, and whose works are carried on continuously, is the expensive and complete nature of the evaporating vessels which are necessary, and which are called vacuum pans. These are machines in which, owing to all the air being extracted, and the syrup boiled by the heat of steam "in vacuo," the watery particles are evaporated from the sugary substance at so low a heat, that not only is the operation carried on with great rapidity, but at so low a temperature that burning or browning the liquid is impossible; and, consequently, the sugar is produced from the vacuum pans in a colourless state, and, on crystallizing, becomes white sugar. All white sugar is thus made.

But these pans are very expensive machines, and require great steam power and skill to work them; and although, doubtless, substitutes of a much more simple form, and at less cost, will eventually be produced, yet at present this class of machinery is entirely beyond any person who is not a capitalist, and may therefore be banished from the minds of the farmer and small manufacturer. But that will not prevent the farmer and small manufacturer from producing the crude sugar before described, and which, when well and carefully made, will be in the very best possible state for the use of the great refiner.

With these observations, I will now proceed to describe how the amateur can decolorize the beet juice and syrup so that it shall crystallize into a form of light brown sugar. It cannot be white without vacuum pans. First, as soon as you have the beet juice boiled down to a tolerably thick syrup, you must (in order to obtain the best results) submit the syrup to the "osmose" process, which is done by exposing the syrup in a thin stratum, on sheets of parchment or parchment paper (the latter is very cheap), while on the other side of the paper, water is applied, so that the water touches every part of the parchment paper. The salts which are contained in the syrup, owing to their being possessed of a greater power of what the chemists call "diffusibility," pass through the parchment paper into the water, while some of the water passes back into the syrup, and thins it somewhat: a little sugar passes with the salts, but in very small quantities; the main body of the syrup remains behind on the parchment paper in a greatly purified state, and is in great measure deprived of the potash and salt which it contained. When the process has been continued for as long a time as you may consider necessary (I have kept it in this position from half an hour to a whole day), you remove the syrup and proceed to evaporate it further, until it gets thick enough to crystallize into sugar: let it remain until the crystals are well formed; then pour it out on a fine sieve or put it into a turbine, and let the molasses drip from it; then the molasses (which contain nearly all the remains of the salts), may again be submitted to the osmose process, and the syrup be again crystallized.

The resulting sugar, when you have enough of it together, should then be redissolved and reboiled, adding to the liquor before it boils, some bullock's or pig's blood, or white of eggs, and a small quantity of finely-powdered bone black. The, blood or eggs and bone black will cause nearly all the remaining impurities in the sugar to rise in a scum to the surface; as soon as the liquor boils, this must then be removed, and the syrup be well strained, and again evaporated and crystallized, and the result will be a brown sugar of tolerable purity.

In order to show how much potash and salt you take out by the osmose process, evaporate the water after it has been exposed to the osmose operation, and finally burn the residue at a red heat in an iron pan; this burns up all the sugar and other organized substances which have mixed with the salts. Then dissolve the ashes of the salts by washing the iron pan, which has been heated red hot, and filter the resulting liquor through blotting or filtering paper; the liquor will come through the filtering paper quite bright and clear, and colourless, but so strongly alkaline that you cannot mistake the potash and salt, or doubt the large quantity which has been removed from the syrup.

What has thus far been written will show any thinking person that the thing to be done for the benefit of the farmer and small manufacturer of Canada, is to manufacture the crude article ready for the use of the refiner and not to interfere in any way with that most expensive and difficult branch of the business.

Full practical information, accompanied by proofs and experiments on a working scale (made in the presence of parties who require it), and also analyses of beet root, so far as the quantity of sugar it contains, will be furnished on application by letter, post paid, to John A. Cull, Esq., P. O., Toronto.

## SUPPLEMENT.

Cost and expenses of labour, and general estimates of one of the great Beet Sugar Factories of Europe.—This is copied from Crocky's work on Beet Sugar, which is the best and most reliable work yet published in English. The reader will see that the allowances for wages and salaries are most liberal.

The factories work day and night, and the wages are reckoned at four shillings sterling *per shift* of twelve hours, which for the old country is very high. The amount of beet roots worked up in this factory is twenty thousand tons in a season. The following is Mr. Crocky's language and figures:—"With perhaps the exception of two or three men, no skilled labourers are required in new beet sugar works, as most of the operations are of a simple mechanical nature, easily taught to inexperienced country hands, by a competent superintendent and his overseers.

The only skilled hands really needed are, an engineer, an hydraulic pump man, a defecater, a sugar boiler, and a bone black burner.

Of these the defecater and sugar boiler should have already had some experience in a beet root sugar factory."

* * * * * * *

We have added as a separate item, the necessary additions to be made for the extra salaries to be paid to specialists in the various departments.

The calculation is based on a campaign of one hundred working days.

### WASHING AND PULPING.

| | *sterling.* | | |
|---|---|---|---|
| Transportation and washing of the beets, 14 men 2 shifts per 24 hours, 2,800 days' labour, at 4s. | £560 | 0 | 0 |

### PRESS DEPARTMENT.

| | | | |
|---|---|---|---|
| Twenty-eight men 2 shifts per 24 hours = 5,600 days, at 4s. | 1120 | 0 | 0 |
| Sack washing and darning, 8 women, 2 shifts, 1,6000 days, at 4s. | 320 | 0 | 0 |

### DEFECATION.

| | | | |
|---|---|---|---|
| Eight men per 24 hours = 800 days' labour, at 4s. ... | 160 | 0 | 0 |

### SCUMS.

| | | | |
|---|---|---|---|
| Six men for 24 hours = 600 days, at 4s. | 140 | 0 | 0 |

### CARBONATATION.

| | | | |
|---|---|---|---|
| Two hundred and fifty days, at 4s. | 50 | 0 | 0 |
| Monte jus (that is steam pump men) | 40 | 0 | 0 |
| Preparation of carbonic acid (*i.e.*, from charcoal) | 40 | 0 | 0 |

### FILTRATION.

| | | | |
|---|---|---|---|
| Three men every 24 hours, at 4s. | 60 | 0 | 0 |

### CONCENTRATION.

| | | | |
|---|---|---|---|
| Two men every 24 hours, at 4s. | 80 | 0 | 0 |

### BOILING.

| | | | |
|---|---|---|---|
| Two men every 24 hours | 80 | 0 | 0 |

### CRYSTALLIZATION AND CENTRIFUGALS.

| | | | |
|---|---|---|---|
| One thousand five hundred days' labour | 300 | 0 | 0 |

### GENERATION OF STEAM.

| | | | |
|---|---|---|---|
| Two shifts of 3 men, 600 days, at 4s. | 120 | 0 | 0 |

### BREAKING AND PACKING.

| | | | |
|---|---|---|---|
| Five men, at 4s. | £100 | 0 | 0 |

### MEN IN THE YARDS, ETC.

| | | | |
|---|---|---|---|
| Five men, at 4s. | 100 | 0 | 0 |

### MANAGEMENT.

| | | | |
|---|---|---|---|
| One general superintendent and two overseers | 800 | 0 | 0 |
| Book-keeper and clerk | 320 | 0 | 0 |

### EXTRAS.

| | | | |
|---|---|---|---|
| Carpenter, plumber, smith, (3 men) | 800 | 0 | 0 |
| Extra pay to skilled labourers | 500 | 0 | 0 |
| General total cost of labour for one year's campaign | £5190 | 0 | 0 |

The quantity of coal consumed in such an establishment as we described, would average 600 tons, which, at 15s. per ton, would cost £450.

The bone black, 30,000 lbs., would cost for the first outlay 2½d. per pound, £312, but in succeeding years would only amount to replacing the waste.

The lime used would amount to 4,500 bushels, and cost £80. 2

The cost of 15,000,000 lbs. of beet root to be worked up into sugar would, at 12s. per ton, be £4,500.

### ANNUAL EXPENSES.

Summing up the above, we calculate that the yearly expenses will amount to:—

| | | | |
|---|---|---|---|
| Labour | £5,190 | 0 | 0 |
| Coal | 450 | 0 | 0 |
| Bone black waste | 100 | 0 | 0 |
| Lime | 280 | 0 | 0 |
| Purchase of beet roots | 4,500 | 0 | 0 |
| Add 20 per cent. for incidentals | 2,100 | 0 | 0 |
| We have a total of | £12,620 | 0 | 0 |
| To which has to be added taxes and insurance, which we have computed at | 400 | 0 | 0 |
| Interest on capital invested | 960 | 0 | 0 |
| Making a grand total of | £13,980 | 0 | 0 |

The total cost of erecting the works for the above factory, is given at £13,157.

This factory is fitted for the manufacture of sugar from beet roots, for the produce grown on 500 acres of ground, which ought to produce at least 1,200,000. One million two hundred thousand pounds of raw sugar.

### REALIZATION.

The products to be realized in our example of a sugar manufactory would be as follows :—

| | | | |
|---|---|---|---|
| Sugar from 15,000,000 pounds of beets, at 8 per cent. of sugar,—the sugar being sold at 24s. per cwt. (of 112 lbs.) | £14,400 | 0 | 0 |
| 2,700,000 pounds of pulp, calculated at ½d. per lb. | 5,620 | 0 | 0 |
| Five thousand gallons of molasses, at 40° Baumé, at 1s. per gallon | 250 | 0 | 0 |
| Residue as fertilizers | 200 | 0 | 0 |
| | £20,470 | 0 | 0 |
| Deducting annual expenses and interest as above ... | 13,980 | 0 | 0 |
| Leaves a net annual profit of | £6,490 | 0 | 0 |

There is every reason to believe that, with careful management, the quantity of sugar will range as high as 10 per cent., instead of 8 per cent., which we have taken as our basis.

In such a case the net income would be £24,470, and the net annual profit £10,090.

Other authors make their calculations on an entirely different basis,—and arrive at results equally favourable, though differing somewhat in detail.

That the above is not too sanguine a view to take of the probable yield is shown by the fact that during the season of 1868, 1869 in the Zollverein, 2,500,000 tons of beet root produced 207,500 tons of sugar, a return of 8·40 per cent.

The foregoing quotations speak, no doubt, of land in the highest state of fertility, and which has been manured for years in the most scientific manner, and also, there is no doubt, of land which has been specially selected for the purpose, and which by repeated crops of beet root very well manured with the refuse, and the results of the cattle fattened, has been brought into the most favourable state possible for the crop.

One of the most remarkable features of the growth of the sugar beet industry is, the constantly increasing crop and yield per acre, which the proper culture of that crop produces, not only in the amount of roots grown per acre, and their richness in sugar, but also in the constant increase of other crops, particularly wheat, throughout the district.

## ANALYSIS OF CRUDE SUGARS AND SYRUPS.

By H. Landolt.

*Translated by J. M. Merrick, B.Sc.*

(Continued from page 604.)

### D. *Determination of the Insoluble Constituents of the Sugar.*

The insoluble constituents of the sugar consist in part of inorganic salts and cellular fibres from the beet roots, but principally of bodies which are only accidentally present in the mass, like sand, small splinters of wood, etc. The total amount of these matters in the sugars examined was exceedingly small, varying, as the accompanying determinations show, between ·019 and ·035 per cent. It seemed, therefore, superfluous to determine the character of these foreign bodies in each single sample of sugar, especially as large amounts of sugar would have to be taken for the experiment, and the determination would consume much time.

It was entirely sufficient to determine the average quantity of insoluble matter in the six different classes of cane-sugar which are compared with the Nos. 15, 14, 13, 12, 11, 9, of the Dutch standards, and finally to make a determination in a sample representing the collective average of the sugars. To this end, sugars of the different classes were mixed in quantities proportionate to those in which they are used in the refineries, and in the same way an average sample of *all* the sugars obtained.

Of each of the so-prepared mixtures, a definite quantity, 300 to 400 grms. was weighed out, treated with water, and the insoluble constituents collected upon a small filter previously dried and weighed. This operation is practicable only when the solutions are much diluted; so they were each made up to a volume of about 10 litres, and the fluid filtered from the glass balloon by means of a self-acting apparatus.

The apparently shorter process, viz., to collect the insoluble matters by decantation, was not applicable, on account of the swimming cellular fibres.

The substances collected were washed with pure water, the filter dried at 100° C. and weighed in a closed gas tube.

The average quantity of the insoluble constituents, reckoned from the numbers obtained for the single classes of crude sugars according to the proportion in which they were present in the average mixture, amounts to ·0227 per cent., which agrees very closely with the average amount ·0238 found by experiment.

The results of these determinations were as follows, viz. :—

| Class of Sugar according to the Dutch standard. | Weight of the sugar mixture used. | Amount of insoluble constituents. | Insoluble constituents in per cent. |
|---|---|---|---|
| 15 ... | .. 316 grms... | .. ·0606 grms. | .. ·0192 |
| 14 .... | .. 493·6 ,, .. | .. ·0775 ,, | .. ·0157 |
| 13 .... | .. 453 ,, .. | .. ·0938 ,, | .. ·0207 |
| 12 .... | .. 398·4 ,, .. | .. ·1025 ,, | .. ·0257 |
| 11 .... | .. 468 ,, .. | .. ·1665 ,, | .. ·0356 |
| 9 .... | .. 420 ,, .. | .. ·1475 ,, | .. ·0351 |
| General mixture of all the sugars | 1000 ,, .. | .. ·238 ,, | .. ·0238 |

The cause of the eleventh group giving more insoluble constituents than the ninth, which in other respects stands lower, lies in the large amount of sand contained in sugar No. 27—of which we have already spoken—belonging to this group.

The following Table III. contains a comparison of the total contents of the various sugars.

To the not determined matters which make up the 100 per cent., belong the inverted sugar, coloring matter, aspartic acid, and apparently some not yet recognized organic matters. The sum of these bodies is, as the table shows, very small, seldom rising above 2 per cent.

TABLE III.

| Crude Sugars. No. | Kind of Sugar. | Cane Sugar per cent. | Organic matters, per cent. | Water, per cent. | Not determined matters, per cent. | Sugar made. |
|---|---|---|---|---|---|---|
| 1 | Clear, light, mixed prod. .. | 95·0 | 1·6 | 2·0 | 1·4 | Dec. '65. |
| 2 | Light mixed prod. ...... | 93·0 | 2·0 | 2·3 | 2·7 | Nov. ,, |
| 3 | Half white, 1st prod...... | 24·3 | 2·3 | 2·5 | ·9 | Dec. ,, |
| 4 | Light mixed prod.......... | 93·5 | 2·4 | 3·3 | ·8 | Jan. '66. |
| 5 | Light mixed prod.......... | 94·4 | 3·1 | 2·2 | ·3 | Feb. ,, |
| 6 | Half white, 1st prod. .... | 93·1 | 2·3 | 3·4 | 1·2 | Dec. '65. |
| 7 | Clear, light, 1st prod. .... | 92·0 | 3·7 | 2·8 | 1·5 | Oct. ,, |
| 8 | Light mixed, 1st prod .... | 93·5 | 3·0 | 2·8 | ·7 | ,, ,, |
| 9 | Clear, light, mixed, 1st prod. | 93·5 | 2·0 | 2·6 | 1·9 | Dec. ,, |
| 10 | Clear, light, 1st prod. .... | 92·0 | 3·3 | 3·0 | 1·7 | Nov. ,, |
| 11 | Clear, light, 1st prod. .... | 93·1 | 3·0 | 2·9 | 1·0 | ,, ,, |
| 12 | Clear, yellow, mixed prod. . | 94·0 | 3·0 | 2·3 | ·7 | Dec. ,, |
| 13 | Yellow, mixed prod. .... | 92·0 | 2·4 | 3·5 | 2·1 | Jan. '66. |
| 14 | Clear, yellow, mixed prod. . | 92·0 | 3·2 | 3·1 | 1·7 | March, '66. |
| 15 | Clear, yellow, 1st prod. .. | 93·7 | 2·6 | 2·8 | ·9 | Jan. '66. |
| 16 | Yellowish, mixed prod. .. | 91·8 | 2·9 | 2·6 | 2·7 | Nov. '65. |
| 17 | Yellow, mixed prod........ | 93·0 | 3·5 | 2·7 | ·8 | Feb. '66. |
| 18 | Yellow, mixed prod........ | 93·4 | 2·9 | 2·3 | 1·4 | March, '66. |
| 19 | Yellow, mixed prod........ | 93·0 | 2·3 | 2·9 | 1·6 | Nov. '65. |
| 20 | Yellowish, mixed prod.... | 93·0 | 3·7 | 3·1 | ·2 | Feb. '66. |
| 21 | Yellow, mixed prod........ | 93·0 | 3·3 | 2·7 | 1·0 | Nov. '65. |
| 22 | Light, mixed prod. ...... | 91·6 | 3·0 | 3·0 | 2·4 | Feb. '66. |
| 23 | Yellow, mixed prod........ | 90·7 | 4·6 | 4·3 | ·4 | Oct. '65. |
| 24 | Yellow, mixed prod........ | 93·8 | 2·1 | 2·8 | ·3 | March, '66. |
| 25 | Yellow, mixed prod........ | 92·5 | 2·4 | 3·5 | 1·6 | ,, ,, |
| 26 | Ord. yellow mixed prod. .. | 90·0 | 4·3 | 3·7 | 2·0 | Jan. '66. |
| 27 | Yellowish-brown, 2nd prod. | 91·3 | 5·1 | 2·5 | 1·1 | March, '66. |
| 28 | Yellow, 1st prod......... | 92·4 | 3·5 | 2·6 | 1·5 | ,, ,, |
| 29 | Yellow, mixed, 1st prod. .. | 89·5 | 4·0 | 3·7 | 2·8 | Jan. '66. |
| 30 | Light, yellow, 1st prod. .. | 92·0 | 2·8 | 3·4 | 1·8 | Feb. ,, |
| 31 | Ord. yellow, mixed prod .. | 89·6 | 4·3 | 3·8 | 2·3 | March, '66. |
| 32 | Brownish, 2nd prod........ | 89·0 | 6·3 | 3·0 | 1·7 | ,, ,, |
| 33 | 2nd product ............ | 87·0 | 6·2 | 4·1 | 2·7 | ,, ,, |

## II.

### *Analysis of Soft Sugar.*

For the investigation of two kinds of soft sugar, which occurred in refining the same, methods were employed as in the case of the crude sugar, since the constituents of both were the same. They gave the following composition:—

| Sugar No. | Cane sugar. | Salts. | Water. | Matters not determined. |
|---|---|---|---|---|
| 1 | 90·5 | 7·2 | 2·0 | ·3 |
| 2 | 89·4 | 8·3 | 2·1 | ·2 |

*(To be continued.)*

## TO TRASH, OR NOT TO TRASH? THAT IS THE QUESTION.

From the *Queenslander.*

It is by a courteous interchange of conflicting opinions that useful facts are discovered. In offering my humbly views hereon, grounded upon practical tests and otherwise, and having no personal object to subserve (it being only a common duty which we all owe to each other), induces me now to present them. Upon these principles I have ever been guided during the unusually lengthy period (since my arrival in 1818) I have been devotedly engaged to prove that, in stated localities, Australia was pre-eminently eligible for the growth of sugar. For more than thirty years all were sceptics to the voluminous truths I hereon expounded, in upwards of two hundred and fifty public letters. Not one line therein has been found to be erroneous. Your colony was the first that practically tested them; then, in 1867, New South Wales was forced to credit them, after the publicly practical proofs I afforded at Kiama; hence, were I to err, that error ought to be admitted to be of a very venial character. But to my subject.

None will impugn this axiom—namely, that all vegetation requires a free circulation of the atmosphere and exposure to the rays of the sun. This fact, together with the advice of blind guides, has (very naturally and allowably so) induced novices to think that trashing the canes is necessary. Denudation is rightly applicable to horticulture, but not to cereals, of which species the cane is one. Its leaves, while green, collect the oxygen from the air, and impart it to the watery fluids furnished by the roots, which convert them into saccharine matter. After performing their appointed office, like all vegetable substances, they wither, die; and ultimately fall to the ground. Examine the juices in such joints where their leaves have either fallen off or are totally dead, and they will be found to be sweet afterwards, needing only congenially warm weather; then try the juices in the upper joints, where their leaves are green, and they will be found to be of a sweetish, watery, and a bitter taste.

It is said: "Trash the canes, to let the sun's beams shine upon them, and to give them air." Now the upper foliage of the canes effectively excludes the rays of the sun from their lower barrels, which have received their needed succour from the *direct* beans of that source of vegetable life, and their action is confined to their exterior woody parts within the outer rind, through which the sap ascends to the upper parts, where vegetation is active, and where Nature invariably places them, in which position they have the full rays of the sun, and a perfectly free circulation of the atmosphere to mature them to their needed maturity. The lower and sheltered barrels need *not* these vital elements in their full and direct action, as were needed when in a green and rapidly-growing state. If these facts be admitted, I ask what tangible reason can be assigned to justify the expensive act of trashing?

Hereon and otherwise I will relate a lucid lesson which Nature exhibited to me in 1843. I then had a very fine plot of cane, in which, when twenty-six months old, during a hot and dry summer, I observed several of their joints split, in which was a purely white substance like flour; this I found to be sugar, which convinced me that when her work was mature she did not commingle sucrose and fructose juices together. On a diminutive scale I cropped a part of these canes, which made twenty-eight ounces of sugar per gallon of juice. The liquid which ran from it was a delicate syrup, of a light gold colour. Samples of the cane, the sugar, and the syrup I sent to a gentleman in Brisbane; I think his name is Cole; on my first visit there he was in the Branch Bank of New South Wales. Now well knowing, as early as the year 1801, that the shorter the time the juices were on the fire the better the sugar was, and less molasses from it, I therefore made a small furnace, and got pans with flanging tops, in which I boiled the juices, not more than two and a half inches deep, whereby I reduced them into liquid sugar in less than one hour. The syrup which ran from the sugar was similar to that described; and as I found that it crystallized into a very fine-grained and perfectly white sugar, I slowly evaporated it over a gentle fire. When thus condensed, before it became quite cold it was one mass of fine-grained and white sugar. This I crushed between two folds of white cotton, which was unstained, thus proving that there was *not a trace of molasses in it.* These events I now note, as they may hereafter form a basis for the improvement of sugar-boiling upon a large scale, and thereby most signally enhance the profits of planters. The canes in question were never trashed beyond that which Nature performed.

I am at issue with Mr. Warren wherein he calls upon tropical planters apparently to support his views; for if any of them do now trash canes within the tropics, except only when harvesting them, ordinary reason clearly points out that, as stated in my first letter, here such a procedure is both unnecessary and injurious. I cannot admit that "trashing" is "cultivation." I quite agree with him when he says that the sugar industry within the tropics has greatly been improved since I was engaged in it; but I cannot believe that it has retrograded so far as to trash the canes while growing, neither do I think, with the advanced cost of labour there, and the low price of sugars as compared to that in your colony, that the planters could afford so heavy an expense.

Thomas Scott.

*Brisbane Water, August* 4.

### Stocks of Sugar in the Chief Markets of the World on the 1st October, for Three Years, in thousands of tons, to the nearest thousand.

| | 1873. | 1872. | 1871. |
|---|---|---|---|
| Great Britain | 219 | 176 | 145 |
| France | 61 | 39 | 28 |
| Holland | 47 | 51 | 35 |
| Germany (Zollverein) | 2 | 3 | 3 |
| Six other *entrepôts* | 7 | 7 | 5 |
| Total in Europe | 336 | 2[illegible] | 216 |

### Consumption of Sugar in Europe and the United States, for Three Years ending 1st October, in thousands of tons.

| | 1873. | 1872. | 1871. |
|---|---|---|---|
| Great Britain | 786 | 695 | 681 |
| France | 268 | 250 | 283 |
| Germany (Zollverein) | 262 | 211 | 211 |
| Holland | 27 | 27 | 22 |
| Six other *entrepôts* | 102 | 88 | 116 |
| Total in Europe | 1,445 | 1,271 | 1,313 |

### Estimated Crop of Beet Root Sugar on the Continent of Europe, for the ensuing Season, compared with that of the three previous Seasons.

*(From Licht's Monthly Circular.)*

| | 1872-73. Tons. | 1871-72. Tons. | 1870-71. Tons. | 1869-70. Tons. |
|---|---|---|---|---|
| France | 395,000 | 335,000 | 289,000 | 289,000 |
| Germany (Zollverein) | 260,000 | 189,000 | 263,000 | 217,000 |
| Austro-Hungary | 205,000 | 162,000 | 182,000 | 151,000 |
| Russia and Poland | 150,000 | 90,000 | 135,000 | 133,000 |
| Belgium | 80,000 | 72,000 | 56,000 | 44,000 |
| Holland and other Countries | 35,000 | 25,000 | 17,000 | 12,000 |
| Total | 1,125,000 | 873,000 | 942,000 | 846,000 |

## SUGAR STATISTICS—GREAT BRITAIN.

To November 15th, 1873 and 1872. In Thousands of Tons, to the Nearest Thousand.

| | STOCKS. | | | | | | IMPORTS. | | | | | | DELIVERIES. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. | London. | Liverpool | Bristol. | Clyde. | Total, 1873. | Total, 1872. |
| British West India | 26 | .. | .. | 28 | 54 | 50 | 103 | 18 | 12 | 53 | 186 | 167 | 95 | 20 | 13 | 40 | 168 | 137 |
| British East India | 14 | 2 | .. | .. | 16 | 10 | 23 | 5 | .. | .. | 28 | 24 | 18 | 5 | .. | .. | 23 | 20 |
| Mauritius ...... | 3 | 1 | .. | .. | 4 | 5 | 14 | 3 | 12 | 11 | 40 | 43 | 15 | 3 | 12 | 12 | 42 | 44 |
| Cuba .......... | 3 | 5 | 1 | 15 | 24 | 24 | 11 | 17 | 23 | 63 | 114 | 114 | 13 | 13 | 23 | 61 | 110 | 101 |
| Porto Rico, &c. .. | 1 | 8 | .. | 4 | 13 | 9 | 4 | 33 | 1 | 17 | 55 | 33 | 5 | 28 | 1 | 12 | 46 | 28 |
| Manilla & Java .. | 30 | 12 | .. | 1 | 43 | 23 | 28 | 13 | 7 | 6 | 54 | 56 | 19 | 6 | 7 | 8 | 40 | 56 |
| Brazil .......... | 3 | 24 | .. | 5 | 32 | 20 | 13 | 65 | 6 | 11 | 95 | 88 | 12 | 54 | 6 | 12 | 84 | 82 |
| Beetroot, &c. .... | 4 | 2 | 1 | .. | 7 | 8 | 33 | 10 | 7 | 21 | 71 | 71 | 35 | 10 | 9 | 33 | 87 | 76 |
| Total, 1873 .. | 84 | 54 | 2 | 53 | 193 | 149 | 229 | 164 | 68 | 182 | 643 | 596 | 212 | 139 | 71 | 178 | 600 | 544 |
| Total, 1872 .. | 64 | 28 | 5 | 52 | 44 increase | | 185 | 129 | 70 | 212 | 47 increase | | 161 | 127 | 71 | 185 | 56 increase | |

## STATE AND PROSPECTS OF THE SUGAR MARKET.

During the past month there has been comparatively little change in the sugar market, prices during the month oscillating between narrow limits.

Although stocks show a decided increase over those of last year at the same time, yet the slight advance in price of the last week and the great increase of deliveries seem to point to a pretty settled condition of the market, yet the tendency seems to be of an upward character.

The disturbed condition of the market, brought about somewhat by the abnormal condition of the money market, seems to be passing slightly away, as things are apparently returning to their normal condition.

The imports for the last year show an increase of 47,751 tons, the deliveries an increase of 56,577 tons, whilst the stocks show an increase of 44,966 tons over those of last year.

The prices current up to the 22nd November are as follows :—

No. 12 Havana and Mauritius afloat are quoted at, respectively, 26s. and 26s. to 26s. 3d., compared to 28s. 6d. to 29s. 6d. of last year.

Fair to good refining Muscovadoes, 22s. to 22s. 6d., against 25s. 6d. to 26s.

Middling to good brown Bahias are worth 18s. to 19s., compared with the last year's prices of 21s. 6d. to 22s. 6d.

The average duty paid of British Refining Plantation is 23s. 6d., compared to 29s. of last year; whilst common refined lump varies from 33s. 6d. to 34s., against the former year's prices of 39s. 6d. to 40s.

We can only say, as we have already said, that although at present prices are somewhat low the tendency of the market seems to be upwards, and that it will probably become easier when the money market regains it normal condition.

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